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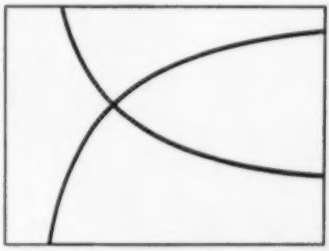

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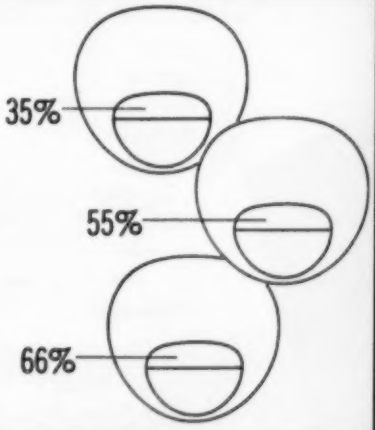

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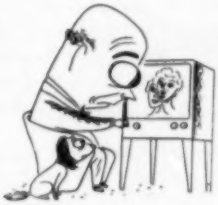

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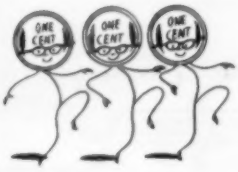

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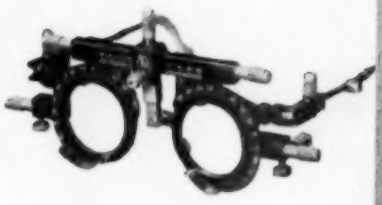

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Vol. 31 March, 1954 No. 3

THE PULLMAN STUDY. — A VISUAL SURVEY OF PULLMAN SCHOOL CHILDREN*

Part I.

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Department of Psychology, State College of Washington
and
Fred J. Newby§ and Mark T. Swindal**
Pullman, Washington

INTRODUCTION

This is the first in a series of papers dealing with a study of school children of Pullman, Washington. This series is an attempt to characterize the development of myopia and to delineate the role played by various factors which have been suggested by other investigators. This paper will present the results of the optometric survey of 650 children ranging in age from five to seventeen years. Later papers will deal with the relationship between these data and other information, such as amount of close work, diet, etc., which have been obtained in other ways. Further, we hope that this represents the first part of a long term study which will enable us to follow these children in their visual development in such a way as to subject most of the suggested etiological factors of myopia to closely controlled observation.

The visual surveys which have been made of school children from kindergarten through college may be classified into those which used visual acuity as the prime measure and those which used a measure of refractive state. This breakdown extends to the methods of handling the results and the interpretations which are drawn. In almost all surveys more measures than these two were taken, some even including a complete optometric examination. However, most investigators have

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This investigation was supported in part by funds provided for biological and medical research by the State of Washington. Initiative measure No. 171.
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§Optometrist.
**Optometrist.

been interested primarily in the number of hypermetropes, emmetropes and myopes and consequently, made use of one or both of these measures for the classification of students.

A review of some of the surveys that have been performed reveals that the static retinoscopic finding is the most often used criterion for classification. School surveys which have employed visual acuity as the classifying measure have been conducted by Boynton,[6] Feldman,[10] Peckman[23] and Wolff.[31] Surveys classifying on the basis of refractive state include those by Ask,[1] Banerjee,[2] Hirsch,[14] Holm,[15] Johnson,[16] Kempf et al,[17] Norgren,[21] Thompson[29] and Wilson.[30] Several surveys, such as those of O'Shea[22] and Sourasky,[27] have made a double classification on both criteria.

Since visual acuity and refractive error are closely related but not identical, (see Hirsch,[14] Kempf et al,[17] Crawford[8]), the results of classification on these two criteria are not directly comparable. But, even if one wanted to compare studies using the same criteria, there are other problems which he must consider. Visual acuity measurements taken under similar conditions with similar targets and the same subjects show considerable variation;[18] while acuity taken with different targets (letters, rings, E's, grids, bars, etc.), as well as with different apparatus (charts, projectors, boxes, etc.) and under different illumination conditions, instructions, distances, etc., must show still greater differences and make the comparability of such data quite hazardous.

The use of refractive state stands scrutiny somewhat better, but still leaves the questions of the differences in measurements due to the use of cycloplegic, fogging, or neither, of what to do with astigmatism and the distance at which the error is measured. Further, there is the question of degree. Does a myope have to have more than one diopter of refractive error before he is called a myope? What shall be the limits of emmetropia?

In spite of differences in methods of measurement and classifications, conditions, etc., most school surveys show a considerable agreement on certain basic results. All of the aforementioned surveys which investigated the indicated factors concur in the following conclusions unless otherwise noted:

(1) The incidence of myopia increases with age, there being between 5 and 10 per cent myopia at about seven years of age and between 23 and 51 per cent at 21 years of age.

(2) The proportion of hypermetropes decreases with age.

(3) Rural children tend to have a lower incidence of myopia than urban children. Thompson found the opposite with 24.2 of 594 rural children having myopia as against 17.6 of 2,655 urban children.

(The important age factor does not appear to have been taken into consideration.)

(4) As nearly as can be determined those children who do more near work or reading tend to have a higher incidence of myopia.

(5) In England, Jewish children have a higher incidence of myopia than do non-Jewish children.

(6) At certain ages girls have a higher incidence of myopia than boys.

THE SAMPLE

While some investigators[14, 17] have attempted to measure a representative sample of the population of school children in order to be able to make generalizations concerning the proportion of various types of refractive error among school children, no such attempt was made in the present study but rather we attempted to measure the extremes of what might be considered a continuum of near work among children. The purpose of this study, therefore, is to compare those children who do a considerable amount of near work with those who do only a small amount, taking into consideration the difficult problem of determining the amount of near work which a child does. This goal was conditioned to a great extent by the nature of the population of Pullman.

Pullman is a college town located in a wheat farming area and the two largest occupational groups in Pullman are college instructors and farmers. In terms of these occupations one could state without reservation that, as a group, college instructors do more reading and general close work than any other group in Pullman. At the same time the farmer group is near the other end of the near work continuum. If one postulates that the children tend to imitate the parents, then the children of the first group should do more close work than the children of the farmers. This assumption is basic to our use of such a population.

A second factor which influenced the nature of our sample was the sending of a complicated questionnaire* concerning such factors as diet, diseases, lighting conditions, hereditary information, amount of close work, posture, etc. Only the children of the parents who answered the questionnaire were tested. This immediately brings up the question as to the differences between parents who answer and parents who do not answer. An attempt was made to evaluate this difference, but we wish to point out that we made no attempt to obtain a representative sample of the Pullman school population.

In the spring of 1952, when this survey was made, there were 1,293 children registered in the five public schools of Pullman. Ques-

*A copy of this questionnaire may be obtained from the authors.

tionnaires were distributed to the 787 fathers of these children. A letter accompanying the questionnaire asked the parents to grant permission to test their child or children and to fill out and return the questionnaire. Four hundred and five of the 787 questionnaires, covering a total of 652 children were returned. All of the parents, whether they cooperated or not, were classified into occupational groups based on The Dictionary of Occupational Titles of the United States Employment Service.[32] The breakdown used is a modification in that the managerial group is handled separately from the professional group. (See Table I.)

TABLE I

Number and per cent of parents in different occupational groups completing or not completing the questionnaire

Occupational Groups	Number Completing	Per Cent of Group	Number Not Completing	Per Cent of Group	Total Group	Per Cent of Parents
Professional	186	59.4	127	40.6	313	39.77
Managerial	38	48.7	40	51.3	78	9.91
Sales and Clerical	28	51.9	26	48.1	54	6.86
Services	25	46.3	29	53.7	54	6.86
Agricultural	51	44.3	64	55.7	115	14.61
Skilled	34	52.3	31	47.7	65	8.26
Semi-skilled	23	60.5	15	39.5	38	4.83
Unskilled	17	30.9	38	69.1	55	6.99
Unclassified	3	20.0	12	80.0	15	1.91
TOTAL	405	51.5	382	48.5	787	100.00

If the two distributions of parents replying and parents not replying are compared by means of the Chi-Square test, we find a very significant difference between the two groups. If we further analyze this difference, using Chi-Square, we find that a significantly higher proportion of the professional group and a significantly lower proportion of the unskilled group returned the questionnaire. There were no significant differences between the proportion of reply vs. non-reply in any of the other groups (the unclassified group could not be analyzed because of the small frequency in the reply group).

These results were expected in terms of the usual results obtained on questionnaires: the most educated groups are the most cooperative and the least educated groups the least cooperative. This occupational breakdown in general follows the same lines.

As may be seen from Table I, the professional group, composed almost entirely of college personnel, makes up roughly forty per cent of the population of parents while the agricultural group is second with about fifteen per cent.

In order to further check our sample, a comparison was made between the children who were tested and those not tested on the

variables of parents' occupation, grade, and number of children in school per family. The comparison on the basis of parents' occupation is presented in Table II and a Chi-Square test indicates that we have a very significant difference between the children tested and not tested in terms of the parents' occupation. This difference agrees with the results of Table I in that about 60 per cent of the children of professional people were tested while less than a third of the children of unskilled people were tested; the children of the other occupational groups were more evenly divided into the two groups of tested and not-tested.

TABLE II

Number and per cent of children of parents in different occupational groups completing or not completing the questionnaire

Occupational Groups	Number of Children Parents Completing	Number of Children Parents Not Completing	Total	Per Cent of Children in Each Group of Parents Completing	Per Cent of Children in Each Group of Parents Not Completing	Per Cent of Total Completing	Per Cent of Total Not Completing
Professional	294	205	499	58.9	41.1	45.1	32.0
Managerial	59	70	129	45.7	54.3	9.0	10.9
Sales and Clerical	41	41	82	50.0	50.0	6.3	6.4
Services	40	51	91	43.9	56.1	6.1	7.9
Agricultural	91	111	202	45.0	55.0	14.0	17.3
Skilled	53	50	103	51.5	48.5	8.1	7.8
Semi-skilled	39	26	65	60.0	40.0	6.0	4.1
Unskilled	31	71	102	30.4	69.6	4.8	11.1
Unclassified	4	16	20	20.0	80.0	0.6	2.5
TOTAL	652	641	1,293	50.4	49.6	100.0	100.0

In terms of the grade placement of the children tested and not-tested we find a significant difference between the lower and higher grades. Of the 856 children in the grades between kindergarten and the sixth grade (ages five to thirteen years approximately), 482 or 56 per cent were tested, while of the 437 children in the seventh to twelfth grades (ages twelve to eighteen) only 170, or 39 per cent, were tested. This disproportion of our sample in favor of the lower ages with respect to the total school population probably means that the proportion of myopia in our sample is less than that of the population, if we make no allowances for the higher proportion of children of professional people. We will consider this point in greater detail later. A partial explanation for this discrepancy lies in our failure to discuss the project with parents of children in the high school and the junior high school before sending out the questionnaires. Such discussions of the survey, its goals, and a request for the cooperation of the parents were made through the P. T. A. in the case of the elementary school children. A lack of time forced a decision as to where to place the emphasis. In

terms of the goals of our study, we felt that we should concentrate on the younger ages, and consequently the nature of our sample reflects this emphasis.

There was no significant difference between the number of children in school per family of the replying versus the non-replying parents.

No attempt has been made to draw a comparison between boys and girls on any of the tests administered except the static retinoscopy which is used to draw comparisons with other studies. The breakdown of sex against age is presented in Table III.

TABLE III

The relationship between sex and age in the children tested.

Age	5	6	7	8	9	10	11	12	13	14	15	16	17
Boys	24	38	37	52	36	26	26	18	17	11	21	19	14
Girls	16	32	41	36	35	37	19	21	17	18	14	11	9
TOTALS	40	70	78	88	71	63	45	39	34	29	35	30	23

In view of the differences, indicated above, between the replying parents and the non-replying parents, the sample tested cannot be considered representative of the population of school children of Pullman, Washington. In so far as we tested 353 children of college instructors, or approximately sixty per cent of the total population of such children, we feel that this sample is representative of the population of college instructors' children. To a much less extent the same may be said about the farmer group.

PROCEDURE

In line with our earlier discussion concerning differences in survey studies which make comparisons difficult, we decided to adopt as nearly as possible the survey procedures laid down by Koch.[19] Koch suggests the following tests be made by a team of seven optometrists: monocular visual acuity at twenty feet, binocular visual acuity at fourteen inches, near point of accommodation, cover test, color vision, all taken by the first man; external ocular inspection and ophthalmoscopic examination by the second optometrist; phoria findings at twenty feet and at thirteen inches by the third optometrist; near point of convergence and versions by the fourth man; dynamic skiametry by the fifth man; fields of vision by the sixth optometrist and summary and interpretation by the seventh man.

All of the above tests with changes in working distances to be noted later, were taken except the near point of accommodation, fields of vision, and the cover test. In addition a considerable number of other tests were taken for specific purposes, some of which will be discussed in

later papers of this series. The tests taken, material and equipment used and the order of testing are as follows:

A recording form* was prepared and stapled to a manila folder. This form was presented to each child as he or she was brought from the classroom to the testing area by an usher. The child carried the folder from tester to tester until the last man was reached. After completing the last test the folder was retained and the child returned to his classroom.

(1) The first examiner, a graduate student, measured child's height, weight, arm length from back of elbow to tip of middle finger, reading distance, bizygomatic index or maximum transverse facial diameter, tested color vision, and determined eye-hand dominance. The examiner used medical scales with a height rod, a yard stick with a stop, a card with a hole, a pair of head calipers and the red-green test plates from the Isochromatic Color Test.

(2) A second graduate student determined, corrected and uncorrected visual acuities monocularly and binocularly at far and near. An illiterate E Chart was used in a darkened room for the far acuity. The chart was illuminated with fifty foot-candles of illumination by means of a floodlight and variable transformer. The near acuity was taken with a reduced illiterate E Card illuminated by a sixty-watt bulb in a goose-neck lamp over the subject's left shoulder.

(3) The third tester, an optometrist, took static retinoscopy, dynamic retinoscopy and red-green findings. This man was equipped, in a separate room, with a screen twenty feet from the subject, a Clason projector, chair and phoropter, and streak retinoscope. The phoropter containing plus two spheres was adjusted in front of the child's eyes and he was instructed to look at a target consisting of 20/50 and 20/60 or larger E's. The right and then the left eye findings were taken at a working distance of 50 cms. Leaving the neutralizing lens in position, the child was asked to read the letters on a card 50 cms. from his eye while the optometrist, working through a hole in the card reduced the phoropter lens power until the high neutral point was found. The finding was recorded as the amount of plus over the static retinoscopy value. After this test the child was directed to the screen again which had the 20/20, 20/30, and 20/40 lines and a red-green bichrome filter. The lens power was reduced until the child indicated that the smallest line he could read was equally sharp in both red and green. Red-green findings were not taken on five-year-olds or on half of the six-year-olds because of the indefiniteness of their responses. All findings were taken without any prescription that the child might have been wearing. Two of the authors worked on alternate days in taking these findings after several periods of checking each other so as to make the findings comparable.

(4) The fourth examiner, the senior author, tested lateral and vertical phorias at far and near and ductions base-out and base-in at far and near. The equipment in a separate room was the same as that used for retinoscopy except for the substitution of a phorometer for the phoropter. All measures were taken at six meters and 40 cms. and with any prescription that the child might be wearing. The same interpupillary spacing of the instrument as was used in retinoscopy was used here. These tests proved to be the most time consuming for the younger age groups. In order to speed this process a graduate student recorded the findings for the operator. In all other cases the operator recorded his own findings.

(5) The fifth examiner, an optometrist, performed an external ocular examination, ophthalmoscopy, rotations and versions and the near point of binocularity. Since the findings were not reported to the children, no attempt was made to summarize the data at this time.

RESULTS

The results obtained on these tests have been entered on IBM cards and have been summarized for each age group, five through seventeen (only six subjects eighteen years old were tested and their results have been omitted) by the use of both point and moment statistics.

*A copy of this form may be obtained from the authors.

TABLE IV

Means, medians, standard deviations and quartile deviations by age group of all visual tests taken.

Average N	40	70	78	88	71	63	45	39	34	29	35	30	23
Age	5	6	7	8	9	10	11	12	13	14	15	16	17
Visual Acuity Far (Denominator of Visual Acuity Fraction-Feet)													
OD													
Mean	21.89	25.00	22.70	24.60	22.60	39.70	41.90	46.95	45.30	50.50	32.85	41.15	47.05
S.D.	5.61	15.10	8.90	15.45	14.05	43.15	49.10	55.45	57.75	55.25	41.05	44.55	62.75
Mdn.	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	15.00	20.00	20.00
Q	3.79	2.95	1.85	2.25	3.30	10.15	11.45	6.50	7.05	14.20	5.00	14.10	4.85
OS													
Mean	22.35	24.30	24.80	24.15	23.45	39.30	39.35	49.20	47.50	42.75	32.70	42.95	33.65
S.D.	4.70	14.45	21.85	15.35	16.90	39.10	41.50	61.40	58.95	46.25	40.05	45.80	42.95
Mdn.	20.00	20.00	20.00	20.00	20.00	20.00	15.00	20.00	15.00	20.00	15.00	15.00	15.00
Q	2.75	2.80	2.20	3.65	3.15	15.85	11.55	8.90	14.90	7.65	4.20	23.25	4.25
Visual Acuity OU (Denominator of Visual Acuity Fraction-Feet)													
Far													
Mean	21.85	23.50	21.75	22.85	22.30	35.15	34.35	40.15	38.80	36.20	21.15	31.65	31.15
S.D.	1.60	14.10	8.15	14.05	14.00	36.10	34.00	45.95	48.90	37.60	36.60	30.15	42.75
Mdn.	20.00	20.00	20.00	20.00	15.00	20.00	20.00	20.00	15.00	17.50	15.00	15.00	15.00
Q	1.40	1.80	1.85	5.15	3.20	10.15	11.85	3.45	3.55	9.45	3.25	8.25	3.60
Near													
Mean	20.00	21.65	22.15	23.15	25.13	23.70	23.90	26.30	28.35	23.60	30.15	23.65	31.30
S.D.	1.60	6.10	7.65	4.70	8.75	7.05	10.70	17.10	31.45	8.45	28.55	8.70	36.30
Mdn.	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Q	1.40	1.35	1.65	1.55	3.30	3.20	2.70	3.20	1.55	1.65	3.60	2.45	3.45
P. D. Far (Millimeters)													
Mean	54.13	54.40	55.72	57.01	57.52	58.70	59.62	60.90	62.09	61.41	62.54	63.67	62.91
S.D.	2.74	2.37	2.75	2.59	2.69	2.50	2.50	2.95	2.74	2.55	2.58	2.58	2.95
Mdn.	55.00	54.00	56.00	57.00	57.00	59.00	60.00	60.00	62.50	61.00	63.00	63.00	63.00
Q	1.94	1.86	1.67	1.84	1.93	1.83	2.12	1.90	1.98	1.68	1.81	1.50	2.08
Static Retinoscopy (Diopters: All findings plus unless indicated minus by a −)*													
OD													
Mean	0.53	0.49	0.90	0.33	0.21	−0.14	−0.22	−0.77	−0.71	−0.15	−0.12	−0.54	−0.32
S.D.	0.67	0.95	1.02	0.91	1.01	1.27	1.01	1.78	1.57	1.13	1.21	1.11	0.89
Mdn.	0.50	0.50	0.50	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	−0.25	0.00
Q	0.44	0.35	0.36	0.42	0.41	0.65	0.55	0.54	0.86	0.52	0.50	0.67	0.35
OS													
Mean	0.48	0.54	0.97	0.27	0.22	−0.06	−0.22	−0.76	−0.42	−0.10	−0.16	−0.85	−0.17
S.D.	0.54	0.86	1.14	0.72	1.02	1.29	1.12	1.85	2.19	1.01	1.17	1.90	0.91
Mdn.	0.50	0.50	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	−0.50	0.00
Q	0.47	0.30	0.49	0.44	0.44	0.65	0.68	0.58	0.53	0.35	0.33	0.51	0.28
Dynamic Retinoscopy (Diopters over the static findings)													
OD													
Mean	1.17	1.12	0.96	0.96	1.06	1.14	1.12	0.95	0.96	1.02	0.90	0.96	1.01
S.D.	0.52	0.46	0.41	0.46	0.58	0.45	0.36	0.28	0.51	0.68	0.69	0.56	0.39
Mdn.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Q	0.34	0.32	0.32	0.51	0.28	0.30	0.35	0.58	0.55	0.31	0.25	0.32	0.21
OS													
Mean	1.20	1.06	0.92	0.92	1.06	1.11	1.15	0.98	1.11	1.02	1.02	1.04	1.06
S.D.	0.42	0.48	0.50	0.46	0.57	0.47	0.40	0.35	0.46	0.49	0.65	0.53	0.36
Mdn.	1.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Q	0.34	0.29	0.46	0.33	0.21	0.32	0.35	0.29	0.34	0.31	0.27	0.36	0.24

Average Age	N	40 5	70 6	78 7	88 8	71 9	63 10	45 11	39 12	34 13	29 14	35 15	30 16	23 17
Red-Green Test **(Diopters: All findings plus unless indicated minus by a −)***														
OD														
Mean			0.38	0.62	0.19	0.06	−0.08	−0.21	−0.83	−0.58	−0.16	−0.17	−0.69	−0.34
S.D.			1.05	0.83	0.84	0.90	1.23	1.00	1.88	1.46	1.08	1.23	1.11	0.92
Mdn.			0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	−0.50	0.00
Q			0.33	0.36	0.28	0.32	0.46	0.55	0.64	0.58	0.44	0.48	0.81	0.61
OS														
Mean			0.44	0.65	0.13	0.04	−0.08	−0.22	−0.81	−0.51	−0.17	−0.22	−0.99	−0.29
S.D.			0.77	1.02	0.39	0.86	1.15	0.82	1.84	1.54	0.98	1.14	1.89	0.88
Mdn.			0.50	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	−0.50	0.00	0.00
Q			0.21	0.36	0.32	0.35	0.56	0.59	0.57	0.51	0.37	0.40	0.81	0.32
Lateral Phoria **(Diopters: All findings plus unless indicated minus by a −)****														
Far														
Mean		2.36	0.12	−0.34	−0.11	−0.94	−0.18	−0.04	−0.44	−0.53	−1.00	−0.69	−1.33	−0.26
S.D.		3.17	2.84	3.96	2.21	3.43	2.24	3.08	2.73	1.49	1.82	3.38	2.10	2.31
Mdn.		2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	−1.00	0.00
Q		2.37	1.50	1.42	0.85	1.06	1.07	1.40	1.35	1.09	1.30	1.26	1.36	0.44
Near														
Mean		2.30	1.09	−0.25	0.41	−0.36	0.36	−0.20	0.53	1.47	0.17	−0.46	−0.10	0.61
S.D.		3.94	4.04	5.08	3.69	5.88	4.11	5.85	7.20	3.48	4.24	5.26	4.49	3.54
Mdn.		1.50	2.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	−1.00	0.00	0.00	0.00
Q		2.52	2.35	3.00	2.67	2.87	2.04	3.75	2.87	2.40	2.56	2.45	2.50	1.53
Blur: Base Out **(Diopters)**														
Far														
Mean		11.20	13.58	13.23	12.81	11.65	11.87	11.82	11.06	10.50	11.46	9.23	10.00	10.00
S.D.		2.87	4.54	3.61	4.43	4.36	5.40	4.26	3.61	3.84	4.68	3.25	3.34	4.05
Mdn.		10.00	12.00	12.00	12.00	12.00	10.00	12.00	12.00	10.00	10.00	9.00	10.00	10.00
Q		1.24	2.97	2.13	2.99	3.05	2.94	2.67	2.17	2.14	3.00	2.96	2.18	3.12
Near														
Mean		15.63	16.29	18.33	18.03	19.47	17.90	18.10	17.34	17.29	17.08	14.26	16.72	17.86
S.D.		3.67	5.17	4.85	4.56	5.86	5.01	4.83	7.35	4.16	6.38	4.77	4.76	5.49
Mdn.		16.00	16.00	18.00	18.00	18.00	18.00	16.00	16.00	18.00	17.00	14.00	16.00	16.00
Q		1.28	3.84	2.33	2.32	4.01	2.38	4.05	4.24	2.81	3.95	2.33	3.94	4.83
Break: Base Out **(Diopters)**														
Far														
Mean		21.80	24.33	28.17	24.85	23.76	22.95	24.02	24.03	22.88	20.62	16.86	18.47	20.96
S.D.		8.48	13.39	10.73	9.42	9.18	8.02	8.75	11.13	7.38	7.13	5.49	5.12	7.19
Mdn.		20.00	22.00	28.00	24.00	22.00	20.00	22.00	20.00	22.00	22.00	16.00	18.00	20.00
Q		4.09	5.92	6.13	5.19	4.83	4.37	6.57	5.97	5.12	6.00	3.79	3.13	4.12
Near														
Mean		27.78	33.04	34.73	31.53	30.65	29.95	28.31	27.97	27.94	28.45	23.57	24.13	25.43
S.D.		8.93	10.49	9.27	6.55	8.71	8.94	7.19	9.18	7.21	11.33	9.15	6.42	10.16
Mdn.		25.00	32.00	32.00	32.00	30.00	28.00	28.00	28.00	24.00	24.00	22.00	24.00	22.00
Q		5.33	6.88	6.29	7.05	5.90	5.97	4.18	4.96	5.01	4.31	4.83	3.12	5.96

Average Age	N	40 5	70 6	78 7	88 8	71 9	63 10	45 11	39 12	34 13	29 14	35 15	30 16	23 17
Recovery: Base Out (Diopters)														
Far														
Mean		5.35	5.01	5.18	5.48	5.81	6.82	6.51	6.30	5.09	6.76	7.49	7.07	7.22
S.D.		7.23	3.38	3.95	4.14	4.49	3.87	4.85	5.56	3.11	3.56	0.31	3.49	3.64
Mdn.		4.00	4.00	4.00	6.00	5.00	8.00	8.00	6.00	4.00	8.00	8.00	6.00	6.00
Q		2.21	2.66	2.74	1.99	2.57	3.42	2.45	2.46	2.49	1.82	1.83	2.38	2.31
Near														
Mean		10.79	10.15	12.00	12.67	11.14	13.38	12.53	11.03	12.06	12.88	7.76	11.10	12.82
S.D.		7.12	7.36	6.78	7.15	6.35	6.40	7.27	14.96	6.71	5.49	5.19	5.42	8.32
Mdn.		10.00	8.00	12.00	12.00	10.00	12.00	12.00	10.00	12.00	12.00	8.00	12.00	12.00
Q		3.97	4.47	5.02	4.79	4.24	4.57	5.53	4.48	4.60	3.37	3.42	3.62	6.00
Break: Base In (Diopters: All findings plus unless indicated minus by a −)**														
Far														
Mean		−10.20	−10.79	−11.18	−8.94	−9.58	−9.36	−9.33	−9.72	−8.82	−7.62	−8.09	−7.40	−7.39
S.D.		2.13	2.66	3.78	3.11	3.03	2.93	2.48	3.94	1.89	3.52	3.07	2.01	1.58
Mdn.		−10.00	−10.00	−12.00	−8.00	−10.00	−8.00	−10.00	−9.00	−8.00	−8.00	−8.00	−8.00	−6.00
Q		1.75	1.94	1.25	1.34	1.34	1.97	1.94	1.21	1.19	1.80	1.75	1.17	1.23
Near														
Mean		−16.59	−20.69	−19.39	−19.82	−19.26	−19.77	−19.36	−19.31	−17.59	−18.48	−18.11	−17.53	−16.78
S.D.		5.36	6.06	5.17	5.25	5.40	4.30	5.13	4.68	4.06	4.90	5.08	5.19	4.80
Mdn.		−16.00	−20.00	−20.00	−20.00	−20.00	−20.00	−20.00	−19.00	−18.00	−18.00	−16.00	−17.00	−16.00
Q		2.84	4.02	3.13	3.67	3.03	2.88	3.30	2.72	2.29	2.30	4.79	4.95	3.23
Recovery: Base In (Diopters: All findings plus unless indicated minus by a −)**														
Far														
Mean		−4.17	−2.94	−2.91	−2.70	−2.86	−3.16	−2.47	−3.21	−3.16	−2.59	−3.34	−2.50	−3.48
S.D.		2.35	2.36	3.80	2.79	2.51	2.95	2.76	2.56	2.26	2.34	1.91	2.44	1.82
Mdn.		−4.00	−3.50	−4.00	−3.00	−3.00	−4.00	−3.00	−3.00	−4.00	−3.00	−4.00	−3.00	−4.00
Q		1.66	1.28	1.37	1.19	1.33	1.21	1.87	1.21	1.06	1.67	0.88	1.27	1.06
Near														
Mean		−7.60	−8.40	−6.08	−8.65	−8.41	−10.03	−9.60	−9.36	−8.65	−8.21	−8.71	−8.20	−9.39
S.D.		4.48	4.90	3.56	5.60	3.33	2.99	5.60	3.86	5.71	4.52	6.65	4.70	4.87
Mdn.		−8.00	−8.00	−8.00	−10.00	−8.00	−10.00	−10.00	−10.00	−8.00	−8.00	−8.00	−8.00	−8.00
Q		2.35	2.53	2.99	3.10	3.02	2.45	4.17	2.84	3.84	2.39	4.21	3.72	4.65
Vertical Phoria (Diopters: All findings plus unless indicated minus by a −)**														
Far														
Mean		0.21	−0.06	0.19	0.09	0.13	0.13	0.18	0.00	0.12	0.07	0.17	0.00	0.00
S.D.		0.60	0.64	0.60	0.31	0.46	0.33	0.42	0.00	0.67	0.25	0.45	0.00	0.00
Mdn.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q		0.28	0.27	0.28	0.27	0.27	0.28	0.29	0.25	0.25	0.27	0.23	0.25	0.25
Near														
Mean		0.32	0.21	0.13	0.33	0.20	0.33	0.24	0.21	0.21	0.10	0.31	0.27	0.09
S.D.		0.78	0.53	0.40	0.71	0.42	0.64	0.51	0.45	0.71	0.52	0.67	0.62	0.26
Mdn.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q		0.30	0.30	0.28	0.32	0.30	0.33	0.30	0.30	0.28	0.28	0.33	0.31	0.27
Near Point Binocularity (Inches)														
Mean		2.42	2.29	2.21	2.37	2.26	2.43	2.23	2.49	2.30	2.70	3.03	3.24	2.74
S.D.		1.31	0.98	0.51	0.88	0.51	0.96	0.42	0.65	0.41	1.39	1.02	1.57	0.74
Mdn.		2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Q		0.24	0.16	0.22	0.28	0.26	0.50	0.14	0.39	0.20	0.40	0.56	0.66	0.24

* Plus indicates the refraction is on the hypermetropic side; minus on the myopic side.
** Plus indicates base out prism; minus indicates base in prism.

The results of the visual tests are presented in Table IV. The results of retinoscopy and the red-green test are expressed as equivalent spheres.

In Table IV the point measures are the median (Mdn) and the quartile deviation (Q) while the moment measures are the mean (M) and the standard deviation (S.D.). In general the point measures are less sensitive to the effect of extreme cases. For example, the only way in which the median visual acuity denominator could be greater than 20 would be for more than fifty per cent of the cases to have an acuity of less than 20/20: in no age group did we find this and, therefore, the median was never greater than 20.

The mean visual acuity denominator increased from the younger ages to the older ages, since the mean is affected by extreme deviations. If we take both of these together, we may say that the degree of myopia increases with age but at no time do the number of myopes exceed fifty per cent, in any age range. The same interpretation holds for the measures of variability, the Q and S.D. In a normal distribution the mean is equal to the median and the more skewed the distribution, the greater the difference between mean and median. Further, in a normal distribution the Q is approximately two-thirds of the standard deviation. As the Q differs from this relationship with respect to the S.D., the distribution becomes less normal.

These relationships must be taken into consideration whenever we seek to draw conclusions from our data and, especially, if we wish to apply any statistical tests which are based on the assumption of normality of distribution. By applying a common test of skewness to the distributions based on all the subjects combined we find that the static and dynamic retinoscopy tests, the red-green test and the phorias, lateral and vertical and far and near, are not skewed significantly whereas all the other distributions are. If we were to consider individual distributions for each age group, we could apply the following formula:

$$\text{Skewness} = 3\,\frac{(\text{Mean} - \text{Mdn.})}{\text{S.D.}}$$

Skewness would equal zero for a normal distribution; the more it differed from zero, the more skewed the distribution in either a positive or negative direction. The only age curves which show a high degree of skewness are the visual acuity distributions.*

*Part II of this paper will appear in the April issue.

SOME NEURAL CORRELATES OF VISUAL EXPERIENCE*

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Research in the field of the psychology of vision can be divided into two distinct types. On the one hand there is the strict study of visual perception — the linking of stimuli to perceptual responses and the elaboration of this process into the investigation of basic phenomena such as the perceptual constancies (size, shape, color and brightness), perceptual judgments as in psychophysics which include the study of illusions, and the role of visual perception in the overall behavior of the individual, its link with the personality and its part in structuring the individual's phenomenal world. On the other hand, with the recognition that like any other type of behavior, the nature of vision depends on the workings of ordered systems of cells and the inter-relationships existing between these systems, there is a type of investigation in which the main problem is one of accounting, in terms of physiological processes, for the multiplicity of visual phenomena to be found in light of scanty stimulus dimensions.

Perhaps the dichotomy of subject matter, which this duality in type of research implies, is artificial. Many of us hope that it is, that the two alternatives are really statements of the same fundamental problem and that some day the lines of research will converge. But it must be admitted that as yet there are few known links between the physiology of vision and the psychology of perception. It is with some interest, therefore, that we find occasional correspondences between the nervous activity of the optical system and associations of stimuli patterns with perceptual responses. The interest becomes excitement when these correspondences indicate the mechanism of the association. In a broad way this kind of correlation is what some of us are trying to accomplish in the study of vision and perception. The work I am going to describe will provide a few illustrations of method as well as of the kind of results we find.

One phenomenon we have studied is called the two-flash phenomenon. Perceptual research has shown that a single brief illumination of a target against a dark field initiates a whole train of alternating

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responses.[5, 6] It is as though the sudden introduction of a stimulus upsets a systemic equilibrium and a series of diminishing perceptual oscillations follow until balance is restored. In every day seeing, these after-effects are not all evident, due to the continuous nature of normal vision, but we do experience both positive and negative after-images quite frequently. However, in the simplified laboratory situation just described, where vision may be said to be discrete or intermittent, some features of the train can be quite outstanding. One such feature is a second flash closely following the primary response though not as bright. This can be so compelling that the naive observer may wrongly suppose that there were two successive illuminations of the target. The question which naturally arises is: What are the limiting conditions for the observation of this phenomenon? In other words, precisely what are the stimulus conditions which call it forth and how does it vary with changed stimulus conditions? The question becomes of even more immediate interest because of certain observations in the field of physiology.

The optic nerve of a rabbit is exposed and electrodes leading through an amplifier to a device for recording changes of electrical potential are attached to it. If a portion of the retina is briefly illuminated and either the duration or the intensity of the illumination is systematically varied the following will occur: For certain optimum magnitudes of either duration or intensity, a double wave of impulses is seen to pass along the optic nerve.[1] The first is the primary discharge or burst of activity following the onset of stimulation. The second, which is quite distinct from the general background of minor activity, is the object of our interest. If the intensity or duration of the illumination be increased or decreased this second wave of impulses disappears. The retina initiates bursts of impulses both at the start and at the cessation of an exposure to light, but the second wave mentioned above is not the same as the "off" response at the cessation of stimulation. Records of successive responses to stimuli, each a bit longer than the last, show the various components of the whole train of nervous activity emerging, and this second wave has emerged and faded out again before the "off" response (itself seen as a second wave in the record) has become clearly differentiated from the primary *on* response out of which it develops. Furthermore, if intensity rather than duration is the stimulus variable, there may be no clearly discernable "off" response at all, due to the shortness of the fixed duration, but successive records of increasing intensity show the rise and decay of this second wave as before. Might not the stimulus conditions necessary to evoke the double-flash phenomenon correspond to those necessary to produce this

double burst of impulses in the optic nerve? Of course, vision does not take place in the optic nerve, but wherever in the central nervous system it does take place, the perceptual experience is constructed from the data that pass along the nerve from the retina to the thalamus. Therefore, the question is a valid one.

Bartley and Wilkinson[4] recorded the intensity of illumination of a target of given size when the second flash just began to appear and again when it just disappeared as intensity was further increased. This was done for various duration times. These are the results: up to a duration of about 60 milliseconds the larger the area of retina involved, the lower the intensity necessary to produce the second flash and the lower the upper limit of intensity where it disappeared. After 60 ms. the upper and lower limits tend to converge again. Thus the *pattern* of stimulus conditions producing the double flash is the same as that producing the second wave in the nervous activity records: that is, a limited number of contiguous duration-intensity combinations are responsible. On a graph, this pattern is seen as an irregular closed polygon. In addition, the time values coincide: that is, the duration of illumination necessary to produce the second wave in the neural records is approximately the same as that necessary to produce the second flash. The same correspondence is found for the intensity variable. Therefore, it appears that the second flash and the second wave are intimately connected if not different aspects of the same phenomenon.

Where and how this second wave arises we do not know, except that it is retinal in origin. At first glance, the existence of two sets of waves in the neural record might suggest the rods and cones in the retinal mosaic. But while it is true that the rods react slower than the cones, the latency is much less than that between the first and second bursts of activity in the nerve. Furthermore, the double-flash is seen only at scotopic intensity levels where cones presumably do not operate, and the double flash is not observed if the illumination is restricted to the fovea where only cones are found. We also do not know what retinal mechanism produces the second burst of impulses.

Various workers have found, as was mentioned earlier, that after the primary flash in the perception of a single pulse of light, there appear seven different phases or after-images: (a) a brief negative phase, (b) a first positive after-image (Hering's after-image), (c) a second negative phase, (d) a second positive phase (Purkinje after-image or Bidwell's ghost), (e) a third negative phase, (f) a third positive phase and (g) a fourth negative after-image.[5] The Purkinje after-image appears between 160 and 200 milliseconds following the onset of the primary image.[6] The second wave appears in the neural record at about the

same latency following the first. However, the Purkinje after-image is complimentary in hue whereas our second flash seems to be acromatic. The Hering after-image is acromatic, but occurs much sooner after the primary flash than does the second neural wave after the first. It may be that under these limited conditions the two fuse. At times the second flash did seem to fade off into a chromatic after-image, though as the illumination was near white, it was difficult to determine whether the chromaticity of this after-image was complimentary or not. My own impression is that it was, but this is speculation. One thing, however, is certain. Assuming that the optic nerve of man will show the same type of response as that of the rabbit under similar conditions, we have found a correlate in neural activity of a simple perceptual experience and have shown that organized neural responses are or can be reflected in experience.

Another phenomenon in which this psychophysiological parallelism is demonstrated is that of brightness enhancement. A target pulsating in intensity so as to produce a perception of flicker may appear to be brighter, equal to or less bright than a steady target of the same physical intensity.[2] The relationship depends upon the frequency of pulsation. According to Talbot's photochemical law, a pulsating source should appear as bright as it would if its total light output were evenly distributed in time. Thus it should appear less bright than the steady target of equal intensity. The maximum increase in brightness actually found over the steady target in this brightness enhancement is approximately twice the steady target and is found when the frequency of pulsation is about 10/sec. This is also the average frequency of the alpha rhythm in the cortex. Thus it is assumed that when the two frequencies (input and natural cortical rhythm) coincide, their effects summate and the result is an increased brightness in the percept. This assumes that the same neural elements in the cortex are involved in the mediation of incoming impulses as are involved in the spontaneous but coordinated activity of the alpha rhythm. Since the image on the retina reflects some light and thus illuminates the whole interior of the eye to a degree depending upon the brightness of the image, it might be thought that this stray light would have its effect also. This was demonstrated[3] when a device was constructed which permitted a pulsating image (for flicker) without allowing the level of stray light to fluctuate. Brightness enhancement was immediately decreased by about one-half indicating both the importance of stray light to the perceptual response *and* that brightness enhancement as a phenomenon is not retinal but cortical thus supporting the analysis of the interaction of the alpha rhythm and the input frequency. Thus we come to the

conclusion that the perception of brightness is intimately connected with the level of activity of the neural elements in the cortex, a quantitative correlation between physiological activity and psychological response.

One more example might be mentioned. At the onset of a train of stimulus pulses (intermittent illumination of the retina), neural activity records taken from the optic cortex, show a chaotic kind of response pattern which gradually settles down to a fairly regular reproduction of the input (stimulus) frequency.[2a] It appears that the various parallel paths involved from the retina to the cortex are organized by the stimulus and "sorted out" according to their natural periodicity and the particular phase of this periodicity or excitability cycle in which the stimulus catches them so that though no one path can follow the frequency because of too great a latency, the frequency is nevertheless transmitted by the successive alternate firing of groups of elements. Thus the pattern of the stimulus is imposed on the response of the optical system as a whole. The question that arises is: Are there any perceptual phenomena which correspond to this brief period of "sorting out" which seems to occur? And what light do these phenomena, if they exist, throw upon the correlation between the physiological and the perceptual?

These are only a few of the examples that might be mentioned of attempts to discover information about the neural correlates of perception, but it is not inconceivable that some day we will be able to explain how the retina acts to "code" the information it receives in the form of stimuli into patterns of neural activity and how this "coded" information is used by the central nervous system in the construction of a percept, which process is vision proper. While the investigations discussed here may appear to have little practical importance at the moment, they presage ever-increasing knowledge of how the eye and its related nervous structures work in the production of visual perception. This knowledge is surely of importance, practically as well as theoretically.

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ACCOMMODATIVE RESPONSE OF THE EYE TO ELECTRICAL STIMULATION OF THE CILIARY GANGLION IN CATS*

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INTRODUCTION

The peripheral parasympathetic pathway for the control of accommodation is well known. The preganglionic fibers appear to originate in the Edinger-Westphal nucleus of the IIIrd nerve center. These fibers help form the oculomotor trunk and go to the ciliary ganglion in the orbit. After a cell station, the medullated postganglionic fibers emerge from the ganglion in numerous short ciliary nerves which pierce the sclera in a ring around the optic nerve. Losing their medullary sheath, the fibers course through the sclera to the ciliary plexus, thence to the ciliary muscle.

The smooth ciliary muscle contracts in sphincter-fashion and, through the zonule fibers releases the tension on the capsule of the crystalline lens. In response to the contraction of the capsule, the lens takes on a higher curvature, thus increasing the refractive power of the eye.

Up to the present time studies of the nervous pathways controlling accommodation (reviewed by Morgan[1]) have been concerned not with the mechanism of accommodative gradation but with the pathways for parasympathetic and sympathetic control of accommodation and their relative roles. The results of these studies indicate that in general only the parasympathetic should be considered of practical significance since the sympathetic, through the long ciliary nerves to the eye, controls only about 1/10 of the total dioptric range, and this in a negative direction.

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The general purpose of this study is to investigate the peripheral parasympathetic mechanism for the graded control of accommodation. Specifically, this paper is concerned with the accommodative response of the cat's eye to electrical stimulation of the ciliary ganglion. This is, perhaps, a first step in the study of the neural mechanism controlling accommodation.

How is accommodation controlled by parasympathetic impulses? It is generally believed that the gradation of motor function depends on two characteristics of nerve propagation: (1) The number (and perhaps distribution) of active fibers in the nerve bundle. (2) The frequency of discharge of these active fibers. These characteristics of motor gradation have been studied in voluntary motor systems[2] and in autonomic effectors[3] such as the sympathetically controlled nictitating membrane of the cat and the parasympathetic (vagus) control of the heart. In so far as we have been able to determine, no one has investigated these control characteristics in the parasympathetic accommodation of the eye.

APPARATUS AND PROCEDURE

A Grass Stimulator (Model 3C) provided the electrical stimulus. This oscillator generates monophasic or biphasic wave forms with variable voltage, frequency and pulse duration. The stimulus was applied to the ciliary ganglion by two polyethylene-insulated solid silver wires (No. 24) held together by a larger polyethylene tube. The electrodes were bared at the tip for about two mm. and separated by about one mm. The electrodes were either hooked around the ciliary ganglion or placed astride it. Generally, biphasic pulses (immediate rise in potential with slow condenser discharge, both plus and minus) were used; however, trials with monophasic stimulation (rectangular waves) yielded similar results. The time constant of the pulse was fixed at one msec., that is, the positive pulse and the negative pulse were two msec. and along with a period of zero potential constituted one cycle up to the beginning of the next pair of pulses. Exploratory data with pulse time as a variable indicated that one msec. gave optimum response. Calibration of the stimulator with a cathode-ray oscilloscope against standard laboratory oscillators and the 60 cycle power mains indicated that the stimulator scale readings were 20 per cent high for peak voltage (without a load), 5 per cent high for frequency and 18 per cent high for the pulse duration used. These errors are not considered serious and are not corrected in the following data and graphs.

The ciliary ganglion was exposed following the procedure of Shen and Cannon.[4] Nembutal was generally used, but in some instances

decerebration provided the anethesia. A portion of the zygomatic process and orbital wall was cut away and the inferior oblique muscle exposed. The nerve innervating this muscle was followed back to the ciliary ganglion, which was found between the lateral rectus and the optic nerve. After the electrode was fixed on the ganglion, the wound was closed with metal Michel suture clips which also held the electrode in place. In order to avoid eye movements upon stimulation, two or more of the extraocular muscles usually were severed.

Circulation to the eye usually was not seriously disturbed. Only a few of the anterior ciliary arteries and veins which accompany the recti muscles were severed. Generally only two muscles were cut so that even these vessels supplying the extraocular musculature were not all disrupted. The ciliary body was still served by its usual primary supply, the long posterior ciliary arteries and the venous return through the vortex veins.

A Rodenstock Eye-Refractometer provided an objective measure of the state of refraction of the eye. The spectacle-plane refraction in diopters was read directly from the instrument dial after the target on the fundus was optically focused. A few drops of 1½ % sodium bicarbonate solution were dropped on the cornea after each three measurements. This maintained its good optical quality and prevented it from drying.

Young, fully grown cats were partially iridectomized from several weeks to several months before they were used for measurements. This surgery was necessary since stimulation of the ciliary ganglion would close the normal slit pupil, making optical measurement impossible. It was convenient to have a piece of intact iris which by a slight contraction following stimulation provided a check on adequate placement of the electrode on the ciliary ganglion. There was no need to employ an artificial pupil as would be necessary in a skiascopic determination of the refractive state, since the entrance pupil of the eye-refractometer was smaller than the exit pupil of the eye by virtue of the optical artificial pupil in the center of the small four mm. annular beam focused in the plane of the pupil. Thus no difficulty was experienced because of the increase of optical aberrations arising from the large pupil of the partially iridectomized eye.

The stimulus was applied for about two seconds, just long enough to obtain a measurement of the refraction. This was read and recorded, again taking about two seconds during which time no stimulation was applied to the ciliary ganglion. Each stimulus value was used three times and the corresponding refractions averaged. Stimulus values were applied in ascending order.

RESULTS

Figure 1 shows the relation between the stimulus electromotive force (E.M.F.) in volts applied to the electrodes at the ciliary ganglion

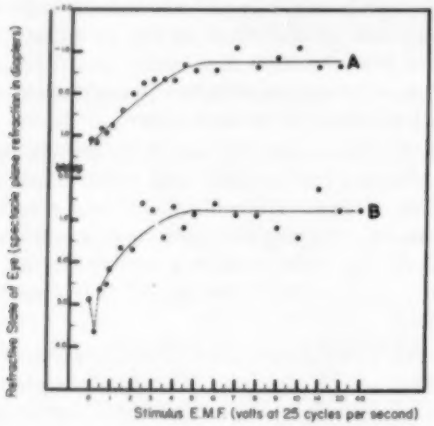

Fig. 1. Stimulus—response curves varying the stimulus E.M.F. A. One eye. B. Contralateral eye of the same cat. Frequently this type of curve plateaus at 3 volts rather than at 5 volts as illustrated.

and the refractive state of the eye as measured at the spectacle plane in diopters. A graded response of accommodation as seen in Figure 1A is produced by varying the voltage of the stimulus. Grading is probably effected by the increasing number of neural elements brought into action by the increasing voltage.*

Figure 1B shows substantially the same result for another eye. It is worth noting that the accommodative amplitude appears to be about two diopters (D.). One interesting difference in Figure 1B is the apparent initial dip in the curve before the rise. Although the dip in this curve is based on only one point, it may be significant as it occurred frequently in similar curves from a large number of cats. However, it

*We have no way of determining in this experiment the effect of E.M.F., nor of frequency on the individual receptors (which are probably the synapses of the ciliary ganglion) or in turn on the individual nerve fibers and motor units. Such data could be obtained by microelectrode recording techniques and is left for future research. As a first assumption the following two points seem reasonable: (1) The frequency threshold of the individual receptors is generally of the same order and gradation is effected by the frequency of the individual receptors *pari passu* with that of the stimulus: (2) The E.M.F. threshold varies over the full range of voltage sensitivity and the number of receptors activated provides gradation. This is necessary to remain within the framework of the all-or-none law. However, no such limitation is required for the frequency mechanism where it is reasonable that the individual receptors will follow the stimulus pulses up to their maximum response frequency which is certainly not reached in this experiment.

must, for the time being, be considered an artifact since there appears to be no likely explanation in terms of present accepted knowledge of the physiology of the eye.** Not infrequently the gradation portion of the E.M.F.-response curve tended to be linear as seen in Figure 1A, but generally this function was curved.

Figure 2 illustrates the effect on accommodation of varying the frequency of the stimulus to the ciliary ganglion. The open circles

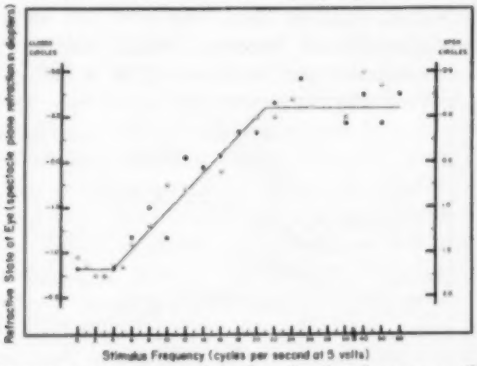

Fig. 2. Stimulus-response curves varying the stimulus frequency. Open circles and scale on the right represent cat under nembutal; closed circles and scale on the left with decerebration.

represent the data from one eye of one cat and the closed circles from one eye of another cat. The ordinates were adjusted to provide superposition of the curves as may be seen from the two scales, one on the left and the other on the right. The stimulus frequency threshold appears to be at about four cycles per second and from other curves not shown here it may vary between two and six cycles. After the threshold, there appears to be a linear relationship between frequency of stimulation and accommodation in diopters. At about 21 cycles, (with a 5 volt stimulus) accommodation appears to reach its maximum and increasing the frequency does not appear to have further effect. The effect of frequency on accommodation can be expressed as the slope of the active linear portion of the curve which, in these instances at 5 volts is 0.10 diopter per cycle. It may be noted that the amplitude of accommodation for both curves in Figure 2 is the same as for both curves in Figure 1, about two diopters. Each of these four curves was obtained from different eyes.

**For example, one could hypothesize that in the cat's ciliary ganglion there are some sympathetic fibers from the third nerve which have a lower electrical threshold than the parasympathetic fibers and are therefore stimulated first. However, this hypothesis would be pure speculation.

In order to determine the importance of the anesthesia used in the present experiment, the curve in Figure 2 corresponding to the ordinate scale on the left (closed circles) was taken after the animal had been decerebrated under ether anesthesia. The other curve (open circles) was taken under nembutal anesthesia. It does not appear that nembutal anesthesia interferes with the experiment and was therefore used generally. The 2.50 D. difference in the ordinates is due to the basic refractive state (ametropia) of these two eyes, not to the anesthesia.

The interrelationship of frequency and E.M.F. on the refractive state of the eye is demonstrated in Figure 3 by a family of frequency

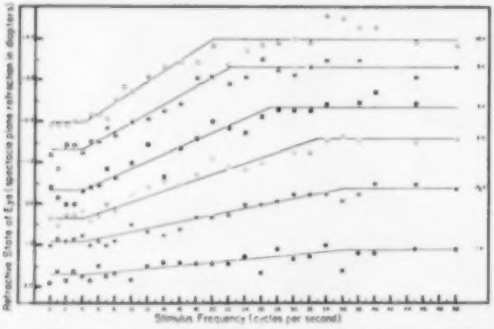

Fig. 3. Family of frequency stimulus-response curves taken at different voltages as noted by numbers at the extreme right. Each curve has been arbitrarily raised 0.50 D. on the ordinate above the curve below it except for the 3 volt curve which has been raised 1.00 D. The shifts were made for clarity of presentation. For fuller explanation, see text.

curves taken at different voltages. The lower three curves (1, 1½ and 2 volt), represent measurements from one eye and the upper three curves (3, 5 and 10 volts), measurements from the other eye of the same cat. Each curve has been arbitrarily raised 0.50 D. more on the ordinate than the curve directly below it, with the exception of the 3 volt curve where the step is 1.00 D. In other words, the 1 volt curve is as measured; the 1½ volt curve is shifted 0.50 D. upward on the ordinate; the 2 volt curve, 1.00 D.; the 3 volt curve, 2.00 D.; the 5 volt curve 2.50 D.; and finally the 10 volt curve 3.00 D. This separation was made for clarity of presentation by avoiding interlacing of the distributions.

It seems clear that the frequency threshold, independent of voltage, is four cycles per second. It also appears that the sensitivity of the frequency gradation mechanism increases with increasing voltage. This is seen in the slopes of the linear central portions of the curves. As the E.M.F. increases through 1, 1½, 2, 3, 5 and 10 volts, the frequency

sensitivity increases through 0.02, 0.04, 0.06, 0.08, 0.10 and 0.12 diopters per cycle respectively. The maximum accommodative response, regardless of frequency, appears to be two diopters. However, this maximum, as already suggested by Figure 1 is not reached until the E.M.F. is raised to between 3 and 5 volts. Within a certain central range of frequency and voltage, these two parameters may be substituted for each other to provide a given level of accommodative response.

DISCUSSION

Bozler,[5] in his classification of muscle, calls smooth muscle "multi-unit" when it is motor nerve controlled and has many units (not syncytial) and hence acts somewhat like skeletal muscle. The nictitating membrane and blood vessel musculature are included in this class. Allen[6] has provided further evidence, based on the latent period of, and temporal summation in the ciliary muscle of an enucleated eye, which puts the ciliary muscle in this group. Further, as Allen points out, the ability to grade accommodation is additional evidence that accommodation is effected by multi-unit smooth muscle. The fine mechanism of accommodative gradation has been quantitatively investigated in the present paper.

The gradation of function of an effector, as already mentioned, is controlled by changing either the number of active units or their frequency of discharge. Lindsley,[2] in an investigation of the electrical activity of human motor units during voluntary contraction, found that changes in both the number and frequency of units operate together throughout the range of contraction intensities. He concluded that change in frequency is probably the more delicate grading mechanism and change in number the more effective. The lowest regular frequency of response that he found in striated muscle was three cycles per second, and the highest 50 cycles per second.

The results illustrated in Figure 3, showing a stimulus frequency gradation sensitivity from four to at least 37 (35 corrected) cycles per second make it appear that smooth ciliary muscle has a frequency innervational pattern similar to that of striated muscle. It seems, further, that either the number of fibers, or the frequency of discharge can control the state of accommodation anywhere within its full amplitude provided a certain minimum frequency, (about 20 cycles per second) or a certain minimum number of units (corresponding to about 3 volts) is maintained.

Unfortunately, there is no simple way to determine the quantitative relationship between the E.M.F. and the relative number of active fibers in the pathway between the ciliary ganglion and the ciliary

muscle. However, it is clear that with a constant E.M.F. (i.e. with a given number of units active), the state of accommodation in diopters is directly proportional to the frequency of stimulation. One might use the term "neurodiopter" to express that unit of neural innervation which changes accommodation one diopter, a term similar to the myodiopter of Flieringa and van der Hoeve.[7] Assuming that the frequency of stimulation may be considered the degree of neural innervation, Figure 3 shows that the neurodiopter is a linear unit when frequency is the gradation mechanism in cycles per second (the reciprocal of the sensitivity) becomes a smaller unit as the E.M.F. (i.e. number of active fibers) increases and Figure 3 shows a decrease of neurodiopters from 52 cycles to eight cycles. In other words, the sensitivity of the frequency mechanism (the reciprocal of the neurodioptric value) is a function of the stimulus E.M.F. (or the number of active fibers). Contrariwise, it appears that the sensitivity of gradation, regulated by varying the number of active fibers, is a function of the frequency.

Are the frequency and number mechanisms independent of each other? This appears to be true at the low frequency threshold where the value is four cycles regardless of the E.M.F. However, there is a significant deviation from independence at the high frequencies where the maximum frequency which increases the response appears to decrease as the number of fibers increases.

Figure 4 is a redrawing of the curves of Figure 3 with the base line of each curve put at the same level on the ordinate. The solid lines show the actual curves, which at the 3, 5 and 10 volt level appear to be prevented from reaching their full height, i.e., amplitude of accommodation. The broken lines in Figure 4 are obtained by extrapolation. They indicate as Hess and others[8] believe, that the neuromuscular phase of accommodation (physiological accommodation) is greater than that limited by the suppleness of the crystalline lens (physical accommodation). In Figure 4, the physical accommodation is two diopters, and the physiological accommodation about three diopters. This could also be checked by using homatropine as a cycloplegic as did Flieringa and van der Hoeve but using the length of the slope as an indication of the full elicitation of the frequency mechanism. In other words, the lower voltage curves appear to show the full function or amplitude of the frequency mechanism. If this full frequency amplitude could be shown with the higher voltages with homatropinization of the eye further justification would be provided for the extrapolation of the curves in Figure 4.

As mentioned earlier, there has been considerable study of the frequency response of autonomic effectors. A summary of these investi-

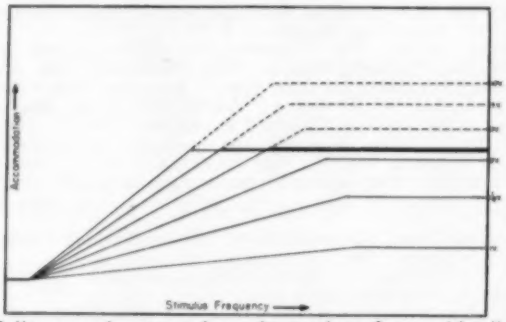

Fig. 4. Solid lines are the curves from the previous figure with all base lines set together on the ordinate. Broken lines are extrapolations. For interpretation, see text.

gations has been published by Rosenblueth.[3] Generally, autonomic frequency-response curves measured in degrees by the angle of movement of pilomotor action in a cat's tail or the isometric or isotonic contraction of the nictitating membrane of a cat's eye are rectangular hyperbolas. The frequency gradation mechanism of accommodation, however, becomes linear when measured in diopters after being transformed into the sphincter-like action of the ciliary muscle and then into dioptric power by changes in the physical configuration of the crystalline lens.* This is indeed a wonder. It brings to mind another interesting linearity, the relationship between accommodative-convergence expressed in angular measure such as degrees or centrads and accommodation expressed in diopters.[9] This relationship is abbreviated AC/A. If, as has been demonstrated here, the relationship between the frequency of accommodative stimulus and accommodation is linear, and if the AC/A is linear, then it can be concluded that the relationship between convergence and the frequency of convergence innervation is linear. This could be confirmed directly by a similar experiment stimulating the extraocular muscles.

The fact that the peripheral mechanism of accommodation appears to have a linear gradation system would seem to imply that the whole AC/A neuromuscular innervational chain is composed of linear links. For if one link in an innervational chain is linear and the system as a whole is linear, then it seems likely that each separate section of the system is also linear.

*However this function is hyperbolic when accommodation is measured in linear units, i.e., meters.

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AMERICAN ACADEMY OF OPTOMETRY

IN MEMORIAM

Anno Domini

1953

Dr. Fannie Gassett, Townsend, Vermont.
Dr. William M. Gilbert, Philadelphia, Pennsylvania.
Dr. Edward W. Larson, Hibbing, Minnesota.
Dr. Samuel Mendell, New York, N. Y.
Mr. John J. Rohrbach, Rochester, N. Y.
Dr. C. H. Wiesepape, Columbia, South Carolina.

Since our last annual meeting the Academy has lost six of its members through death. Each of these men played a significant part in the development of the profession and each by his splendid work has left his important mark on the present and future of optometry. All have been active in the Academy. We miss these important leaders and the membership of the Academy at this time pays tribute to their memory.

(From the minutes of the Chicago, Illinois, meeting of the Academy.)

COMMENTS ON THE USE OF THE PTOSIS CRUTCH*

Arthur E. Tillisch†
Minneapolis, Minnesota

Some of the literature on the use of the ptosis crutch may appear to convey the erroneous impression that the prescription of this device is itself sufficient therapy. This is not the case, and it would be tragic if the practitioner resorting to this device meets failure through insufficient subtlety in its application. "Tragic," because it is doubtful if any aspect of optometric therapy can yield greater gratification in terms of concrete achievement and resultant patient thankfulness, than the adroit use of the ptosis crutch. It literally removes a veil from a sufferer's eyes and permits him to exercise his gift of vision like normal people do. In fact, the beginning practitioner, justifiably anxious to establish his reputation in the community, would do well to seek out, within the limits of professional propriety, neglected ptosis cases and suggest to them that a means of possibly alleviating their condition exists.

Certain procedures are to be observed, if success is to be facilitated. I am not now referring to mechanical details of construction. These are to be worked out in cooperation with a skilled optician, keeping in mind at all times the individual needs of the patient, in light of the unique features of his facial configuration. A prime object in this connection is to have the crutch rest firmly yet gently on the upper lid covering the globe of the eye. Apart from thus providing adequate support without irritation there is a supplementary and important purpose here: to provide a massaging effect on the lids when the eyes rotate to obtain fixation. This results not only in helping restore tonicity to muscles atrophied through disuse, but may also facilitate dormant neural functioning. I am aware that this latter aspect may be questioned, but I believe an adequate literature exists to substantiate the hypothesis that neural growth and possibly rejuvenation may be a function of such activities as mechanical stimulation. To obtain maximal benefit from this massaging activity, the crutch supports must conform to the individual features of each lid and eye and the orbital structure, resting in the palpebrae at the superior margin of the fissure just beneath the frontal bone.

While passing no judgment as to whether vision is a learned

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†Optometrist. Fellow, American Academy of Optometry.

skill, as some claim, or actually the maturing of innate mechanisms, it is nevertheless true that the *will to see* is an important aspect of visual acuity. Initially, a ptosis patient, even when the lid is uplifted, may display near blindness. Wandering around in a world of semi-darkness and blurry images, he has lost the cerebrally focalized skills of (1) correct integration of images, (2) correct differentiation of images, and (3) adequate completion of visually inadequate cues (this includes a factor of interpretation).

Consequently, if the patient is hyperopic or emmetropic, it is advisable often to prescribe plus considerably in excess of what the retinoscopy initially indicates. This may be done even if no immediate improvement in visual acuity results. The excess plus has the role of (a) magnification, (b) permitting the patient to exercise his vision at near on small and easily integrated contours and (c) permitting vision with minimum accommodative effort, which is especially important in this instance when the accommodative faculty has not been fully exercised. Maximum tint is also desirable initially, for obvious reasons. Reexamination in a few weeks is then scheduled.

It is important to explain to the patient in detail what is being done for him and that both his cooperation and patience on the road to visual normality are needed. This cooperation is usually not difficult to elicit, since the patient is eager for any improvement and does not himself expect miracles.

On reexamination, increased acuity is noted and demonstrated to the patient. The over correction may then be reduced and a lighter tint prescribed. Often, about four changes of lens prescription within a period of about eight months is indicated. This, of course, is a function of rate of improvement.

What of the situation when the ptosis is unilateral and the patient has successfully adapted to a mode of uniocular vision? Again, the needs of the individual situation are our guide. The ptosis crutch may then be used primarily for its marked cosmetic improvement, assuming that visual readjustment is not the major object. When skillfully constructed, a ptosis crutch can be nearly invisible. This was amusingly demonstrated when a ptosis patient entered my office for reexamination. I invited a visiting optometrist to examine her, and not until he had removed the frame did he realize, with some shock, its special construction.

CASE HISTORY-BILATERAL PTOSIS

Although this patient has been under my care for twenty-four years, she could not resist recently sending me yet another letter reciting

her indebtedness. She recalled our initial meeting—in a restaurant. She was twenty-four years old then, having had the condition for twelve years. When I first saw this patient she was attempting to eat by holding one eyelid up with her left hand, while manipulating her spoon with the right hand. Even thus, she had to tilt her head very close to the table, to see even the rudimentary outlines of the objects there. We were informed that medical resources had been exhausted without help.

Examination revealed no visible control of lids. They had to be lifted manually to obtain a visual acuity of 20/400 with either eye.

The initial prescription was +4.00 D. sph., O. U., with a #4 Crookes tint. We advised her parents to keep the patient in a darkened room for several weeks, gradually increasing the illumination as she became more accustomed to light. The instructions were carefully followed and the improvement in visual acuity was rapid. Within a year, she was wearing +1.50 D. sph., O. U., with a number one tint. She had also obtained visual acuity of 20/20, which is today her present visual status.

When recently examined, she reported enjoying all normal visual activities such as reading, sewing, observing television. Since there was insufficient control of ocular movements to justify bifocals, the writer prescribed a pair of reading glasses to supplement those already in use for distance purposes. It is today difficult for any observer, without a very close examination, to notice any visual abnormality in this patient, or that she is wearing a corrective device.

AMERICAN ACADEMY OF OPTOMETRY

NEW MEMBERS OF ACADEMY

The following optometrists were elected to Fellowship in the American Academy of Optometry during January and February, 1954. The Academy welcomes these new members.

Dr. James P. Leeds, 2112 East Tenth St., Indianapolis, Indiana.

Dr. Norman M. Lillos, R.O., 320 Columbia St., New Westminster, British Columbia, Canada.

Mr. Cyril J. Pettet, 420 High Road, Leyton, London, England.

Dr. Jack Harvey Prince, Department of Ophthalmology, Medical School, The Ohio State University, Columbia, Ohio.

Mr. T. W. Watts, 8 Castle Meadow, Norwich, England.

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A $1,500,000 A YEAR. — FOR AN ADVERTISING-PUBLIC RELATIONS PROGRAM FOR VISUAL CARE

Although optometric services are now generally accepted it is agreed among the profession that a vigorous well planned advertising-public relations program of national scope is needed to further augment the present interest in eye care and to reach the millions of potential patients who have uncorrected or neglected visual problems.

On several occasions in the past the American Optometric Association has explored the possibility of raising a large sum of money, in one instance a million dollars, for this purpose. These plans never were put into operation. In more recent years Regional or State groups of optome-

trists have attempted similar programs on smaller scales and with varied success.

That the need for a public relations program exists, most optometrists agree. The problem is to get overall support for a plan and implement it with a program that can and will really do the job. Small amounts of money will not suffice. In these days of large advertising appropriations, modest sums are more or less lost in the competition for public attention in the mass media of magazines, radio and television. Ideally, the program itself should be on a national basis, and it should be financed through a plan in which all those who benefit will contribute equally.

Recently the proposal has been made by the Independent Optical Wholesalers Association that a large sum of money be continually collected and that a nation-wide, long-range program of public education be conducted so that millions of patients and potential patients will be made more eye conscious.

The proposal is a simple one and we are told that some of the manufacturers of lenses and frames are inclined to regard it favorably. The proposal is—that all manufacturers of these items agree to charge, collect and set aside the sum of five cents (5c) for each spectacle frame sold, and also charge, collect and set aside the sum of five cents (5c) for each pair of lens blanks made and sold by them.

The money collected in this manner by each manufacturer would then be placed in a special fund to be administered by a joint committee of manufacturers, wholesalers, laboratory representatives, optometrists, ophthalmologists and opticians. The funds would be spent by the Better Vision Institute in a continuing, huge advertising-public relations campaign which would develop interest in visual care throughout the nation. It is estimated that at present a fund raised in this manner would exceed $1,500,000 each year.

The proposed plan has the following advantages: (1) The money will be expended by the Better Vision Institute. With a modest budget of $175,000 each year the B.V.I. has already demonstrated that it can do very effective work. The spurt which the B.V.I. could give the entire field of visual care with a fund of $1,500,000 to spend would please and surprise us all. The B.V.I. is an already created industry-profession organization, with a long and fine record of success in the specialized field of advertising-public relations work for optometrists, ophthalmologists and opticians. At present it is financed by membership contributions. With the new plan these could continue for special assignments and the large national advertising campaign would be financed and

made a reality by the public relations assessments of five cents on each frame and each pair of lenses.

(2) The plan as proposed would raise an amount of money sufficient to conduct a national advertising campaign designed to send thousands and thousands of new patients to their optometrist or ophthalmologist for refractions. Optometrists will naturally get their share of this new work, and a big national campaign of this sort would help focus attention on our sectional and local public-relations campaigns now in progress.

(3) With a minimum of $1,500,000 available each year, full page ads would be scheduled in such media as the SATURDAY EVENING POST, COLLIERS, LIFE, TIME, etc., and real live talent shows would be offered the public on both radio and television. Ads which will in this way reach millions of readers each month—and well timed shows will be heard and watched by millions of others. The impact of such a co-ordinated program would materially increase the demand for visual care at all levels and in all parts of the country.

(4) The strength of the proposed program of advertising-public relations rests on the point that all segments of the industry and the allied professions would contribute to its success. With all manufacturers participating, every user of frames and lenses is automatically assessed and separately billed for his share in this program, at the rate of five cents for each frame used and five cents for each pair of lenses. Even the present day "quickie" refractionist would contribute—since he would have no choice: however, the campaign would emphasize proper first class visual care and might force the commercialists to raise the level of service they give to their patients.

While the plan is still in its early stages—and may not materialize —the proposal holds out the first and really workable plan for a large size advertising-public relations campaign which would cover the nation, and do a really needed job in selling eye care.

We hope optometrists will support the idea and encourage those working on the plan at B.V. I. headquarters, to put it across. The Independent Optical Wholesalers Association has given its approval although it will entail much additional bookkeeping work on the part of its members. Optometrists could and would add these small costs to their present day charges for materials and pass them on to their patients. A total of ten cents is little enough for the patient to pay periodically for the continuing stimulant, to them, to conserve their vision.

CAREL C. KOCH

SPECIAL REPORT

EVALUATION NEEDED OF ORTHOPTIC PROCEDURES AND TECHNIQUES*

Thaddeus R. Murroughs†
Northern Illinois College of Optometry
Chicago, Illinois

GENERAL PURPOSES

1. To recognize and define some of the general areas in the field of orthoptics which need formal investigation.

2. To consider those aspects of these problems which demand attention.

SPECIFIC OBJECTIVES CONSIDERED

During the course of the year it became apparent that the duties of this committee would involve four basic phases before the assigned purpose could be carried out. These are:

1. The standardization of terminology.

2. The evaluation of diagnostic procedures in heterotropias.

3. The evaluation of training procedures.

4. The selection of a pertinent problem with careful outlining of the method of attack, particularly with reference to the diagnostic tests which should be used. This work could be carried out in various clinics and practices. Detailed case reports could be prepared and should include the outcome of those cases which responded orthoptically on the basis of a series of diagnostic tests. For example, it is possible to test cases for anomalous correspondence (after measuring the subjective and objective angle of the deviation) by using Hering's after-image test. These tests could be given a number of times, and then after orthoptic training or surgery or both, the results could be correlated with the diagnosis.

This approach carried over a period of years by a number of men in the country would yield factual information which today is not

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†Optometrist. Member of faculty. Fellow, American Academy of Optometry.

readily available. Let us consider each of these four basic phases in turn.

TERMINOLOGY

There is no aspect of optometry in which erroneous ideas are as prevalent as in the field of ocular motility and strabismic vision, and in which elaborate techniques and questionable conclusions have been erected on such flimsy foundations. It is trite to state that we need more information and understanding of strabismus and its cure. However, before we can exchange information we must understand the terminology.

The five men serving on this committee are educators, each working with his own concepts and definitions. We impart these definitions and interpretations to our students and year after year the difficulty in communicating with each other grows greater. We have varying concepts about a single phenomenon, and these are so divergent, partly because of confusion in terminology.

The term "anomalous correspondence" will serve as an example. Swan has defined anomalous correspondence as a condition in which it can be demonstrated that the two foveas are not corresponding. Member "V" on our committee agrees with this definition, but several other members do not. Committee member "W" has difficulty in following member "X" who talks of anomalous projection. Member "Y" confuses anomalous projection with anomalous fixation and past pointing, and claims that both are different from anomalous correspondence but yet anomalous projection is a common phenomenon to all three. Several members do not agree with this thesis. Member "Z" has difficulty in understanding "Y's" distinction with respect to anomalous correspondence.

Member "Z" does not agree that the committee should limit itself completely to the matter of defining terms as there are a number of reference works already available in this field. However, there is lack of agreement even among the authorities in the field.

As a beginning the committee might consider some definitions proposed by men of experience who are familiar with both sides of the problem. Evaluation of Lancaster's paper on "Terminology in Ocular Motility and Allied Subjects" (Amer. Jour. Ophth., Feb., 1943) would be a good way to begin.

In the attempt to outline diagnostic and therapeutic procedure, there is need for universally understood terminology. With it several purposes would be served. Lancaster has pointed out: "The first essential for any science is to agree on a terminology with exact definitions in order that one may speak the same language and write in exact terms concerning it." An exhaustive analysis and consideration of as few as three or four terms would make an excellent symposium for next year's program.

The opinion of this committee is that terminology must be standardized; a set of definitions must be drawn up. This is the best service the committee could render in the coming year. Initially, whenever possible, the definitions should be operational rather than theoretical, but some will have to be theoretical.

EVALUATION OF DIAGNOSTIC TESTING PROCEDURES

Before the committee can evaluate diagnostic test procedures it is necessary to select the tests which will be used. Before selecting these tests we should decide which functions we want to test. Finally, we must ascertain that a particular test is measuring or testing the function for which it is used.

On the basis of these thoughts some system of classification of the tests should be set up. One suggestion contains the divisions: (1) testing motor functions, (2) testing monocular functions, (3) testing binocular sensorial relations.

Under each of these three headings it will be necessary to consider a large number of tests, under varying conditions, with many modifications. Before proceeding further, it will be necessary to make some standardization of test conditions so our work will be uniform and thus comparable, not only from one patient to another but between different workers as well.

Another classification for evolving a testing battery is suggested by the divisions of the field of strabismus as proposed by Bielschowsky: (1) mechanical factors, (2) innervational factors, (3) fusional deficiences, (4) sensorial anomalies.

The general approach to the problem consists of two interrelated phases, that of establishing a differential diagnosis and of working out a valid prognosis. In order to deal with the testing situation directly, we should decide what particular visual functions should be tested in examining a strabismic subject, and then which test or tests are the most valid, the simplest to understand and the easiest to perform for the function being tested. Responses to certain tests may serve as a point of departure from which training procedures can be initiated.

The selection of proper tests is the greatest stumbling block since there are many ways of testing the objective and subjective angles of the deviation, each test giving somewhat different results.

To embark on a program of evaluating various tests would seem to be the most valid approach, but would undoubtedly be extremely time-consuming.

This aspect of the problem cannot be overcome within a short period of time unless the committee members decide among themselves, on the basis of past experience, which tests will be most adequate for the function to be tested.

Each member can submit a list of visual functions which he is now testing, the tests used, and the diagnostic and prognostic significance they place on such information. We could use this as an initial step in solving this phase of the problem.

Each of these points should be evaluated critically by all and the participants should strive to reach a point of agreement, at least on the phenomenon and on the meaning of the terms for describing it.

Another approach which might be feasible is to identify and list the salient characteristics or criteria for diagnosis of the various anomalies or conditions within the anomaly if complicated, such as, convergence insufficiency, divergence excess, accommodative strabismus, amblyopia, anomalous correspondence, etc. The essential tests could be listed and amplified in steps under various conditions.

By comparing such lists of responses under various class headings, a rational system may be set up by which a differential diagnosis can be established. One inherent difficulty present at the outset is that we shall have the categories set up on the basis of our past experience and library research and probably we shall try to fit the patient into an already established category. Although this approach has its limitations it may prove useful, after an exhaustive analysis of each test has been made, in indicating a series of treatments for the various types of anomalies.

EVALUATION OF TRAINING PROCEDURES

Using the case type identification as described in the previous section with its distinguishing features listed below, the essential steps or procedures in treatment could be written up on a parallel sheet. It may be found often that the treatments are not related to anything mentioned in the diagnosis and in pointing this out a more comprehensive diagnostic evaluation or modification of the orthoptic procedure may be indicated.

Ultimately the aim should be to choose the various procedures in terms of principles rather than by blind adherence to a technique or system. This would also avoid the bias of working from an insecure foundation based on questionable assumptions which tend to assume the status of fact.

Eventually this approach would lead to the formulation of theoretical hypotheses which would serve as points of departure for future studies. Evaluation of training procedures and the development of theories, although extremely desirable and related to the problem, does not fall within the scope of the immediate task assigned to this committee.

SELECTION OF A PERTINENT PROBLEM

The general divisions of the field may be set up as:

1. Essentially motor problems, which include changing a tropia to a phoria.

2. Essentially monocular problems which include amblyopia, lack of central fixation, faulty monocular projection or localization.

3. Essentially sensorial problems of binocular vision, e. g.:

a. Anomalous retinal correspondence.

b. Anomalous projection.

c. Development of fusion at the crossing point of the visual axes.

d. Stereopsis at the crossing point of the visual axes.

To progress in each of these three divisions, or any other method of division, the following steps should be considered:

1. Terminology:

a. Let us see whether we can agree on the meaning of terms and use the same term for the same thing.

b. Each term should be used operationally at first, and since every term carries with it some theoretical implication, we should be careful with regard to these theoretical aspects and treat them as hypothetical.

c. For example, consider anomalous retinal correspondence as a term. Tests for correspondence can be done in the following two ways:

(1) Determine the subjective and objective angles of squint and then see if there is a jump on the cover-uncover test.

(2) Determine the objective angle by the cover-uncover method. Then determine whether the two objects placed on the visual axes appear superimposed.

We have seen patients whose response is anomalous by the first method and normal by the second. Accordingly we hope that the operational meaning of the terms will be quite specific.

d. Theoretical implications of the terminology.

If a patient gives anomalous responses to both operations just described, is this an anomaly of correspondence or of projection? Normal retinal correspondence implies the presence of fusion, luster and stereopsis which these patients do not seem to possess for the anomalously corresponding retinal areas. These areas, except for a correspondence in projection, do not appear to correspond at all.

While the presence of fusion, luster and stereopsis does imply normal retinal correspondence (rather than vice versa), our member "X" does not see where this point invalidates the concept that anomalous retinal correspondence is characterized by anomalous relative directional spatial values. Boeder's translation of Tschermak shows that it is better to speak of "anomalous unity of visual directions" rather than "anomalous correspondence."

2. The second part in this sequence is to compare and evaluate various testing procedures and to develop new ones where needed.

Member "Y" offers two such examples:

a. In amblyopia, can some means be devised by which we can test monocularly the function of the central 10 degree field? Particular emphasis might be given to the acuity gradient in this area.

b. With regard to corresponding retinal areas: when the visual axes are sen-

sorially corresponding, what is the relation between peripheral areas? Eikonometer tests are limited forms of such a testing procedure. Member "Y" favors field mapping of corresponding points.

3. Evaluation of training procedures.

Training procedures should be tried, expanded where necessary and redefined in terms of principles. In some procedures the training given is sometimes directed toward improving a certain function or skill which has not been found to be deficient in the original diagnosis. The time might be spent much better if the exercises were always directed toward improving what has been found lacking. If a more complete diagnosis were made of the deficient or anomalous function or functions, it would help to point out those exercises which are necessary.

It will be difficult to work out a program so that the results have statistical as well as practical significance. Even though we may not succeed, every effort should be made in this direction. This appears to be a most important part of the program at this point.

4. The fourth point is to establish the validity of the various tests for prognosis on the basis of success or failure in training. If we can develop the program to this point we shall at least be able to appraise the clinical value of the tests.

5. Following this and on the basis of pooled experience, we may be able to develop some theories that are testable. These theories may involve etiology, perception, innervational considerations, fusion mechanisms, and the like. The pooled information should generate some sort of hypotheses which we do not have at the present time and which would indicate a direction which may lead to fruitful research in this complex field.

SUMMARY

1. A systematic attack and investigation of a specific problem in the field of heterotropia and amblyopia depends to some degree on our ability to evaluate training procedures and testing procedures.

2. The evaluation of training procedures depends upon a differential diagnosis on the basis of valid diagnostic testing procedures.

3. Diagnostic testing procedures depend upon a selection of a test battery, and an accepted terminology in terms of functions tested, tests used, and the interpretations given these tests.

4. In the last analysis the starting point for the entire sequence is resolved to a matter of basic terminology.

RECOMMENDATIONS

1. The Committee submits the following terms and definitions for formal consideration by the Orthoptic section.

Visual Training or *Orthoptics:* An optometrically developed

procedure dealing with the disabilities of seeing, faulty binocular vision, and incoordination of ocular motility, through the use of measures such as occlusion, refraction, and training instruments, employing physical, physiological and psychological principles, and designed to teach the patient to obtain the most efficient use of his eyes. The method develops or restores the normal integrated binocular functions by means of graded exercises which involve sensory, perceptual, and motor components.

Strabismus Training: The treatment of strabismus, exclusively concerned with the reconditioning of, or acquiring a reasonable state of functional parallelism of the eyes for comfortable and efficient binocular vision. It also deals with the conditions which render binocular vision difficult: e.g. heterophorias which may be borderline tropias.

Acuity Training: The treatment of amblyopia and any other defects involving subnormal vision.

Imbalance Training: The treatment of derangements in the relationship of accommodation and convergence.

Achievement Training: The improvement of efficiency in performance of specific functions in terms of enhanced performance, improvement in speed and/or comprehension, e.g., stereopsis, fusion, speed of perception, span of perception, reading rate, etc.

2. It is recommended that at a future Orthoptic Section meeting a symposium be held:

a. On the topic of terminology—a selection and exhaustive consideration of as little as three or four terms would make a good program.

b. A consideration of any basic diagnostic tests which the committee could cover in its work during the coming year.

3. For future symposia consideration should be given to a system worked out for the classification of:

a. Major classes of tests in terms of motor, monocular and binocular testing.

b. An order to the tests, classified on some concrete basis.

c. A diagnostic differential diagnosis evolving from the tests used.

d. Identification of case types for orthoptic purposes.

e. The formal recognition of principles in training procedures.

TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY

A department devoted to announcements, reports, appointments, organization data, news, professional problems and ideals, as these relate to the Academy.

MANUAL OF INSTRUCTIONS FOR APPLICANTS*

Harold Simmerman†
Wenonah, New Jersey

Because some misunderstanding has occurred in the procedure of admitting new members into Fellowship in the American Academy of Optometry, the *Manual of Instruction for Applicants* has been rewritten to eliminate possible future confusion.

As Chairman of the Committee on Admittance, it is my privilege to invite optometrists to affiliate with the Academy. Our Committee and our Chapters are prepared to assist all applicants and we urge optometrists everywhere to affiliate.

The Committee on Admittance wishes to thank and acknowledge the Executive Councils' help in the revision of the following manual and wishes especially to express its appreciation to President Morgan for his constructive aid in preparing this material. The committee is confident that the members of the Academy and prospective applicants will readily understand and follow its simple outline form.

I. THE OBJECTS OF THE ACADEMY.
   A. The primary object of the American Academy of Optometry shall be to further the development of optometric science in its efforts to conserve human vision by:
      1. Affording an opportunity for the presentation and discussion of the results of clinical and experimental research in visual problems.
      2. Encouraging the scientific observation and reporting of exceptional and instructive conditions encountered in the practice of the individual Fellow.
      3. Initiating and supporting, in suitable centers and institutions, research programs in optometric subjects.
   B. Second, the American Academy of Optometry fully realizes and willingly assumes its responsibilities of leadership in the field of professional optometry to the end that it will ever stand for those principles of high ethics, increased educational standards, and unselfish service to the public, as opposed to the forces of commercial agencies which seek to degrade every aspect of the profession.
   C. Third, in order that these principles may be accomplished in fact, the American Academy of Optometry has not only formulated, but is guided by a

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†Optometrist, Fellow, American Academy of Optometry. Chairman, Committee on Admittance.

strict code of ethics. Furthermore, to assure continued maintenance of these standards, the Academy has adopted rigid entrance requirements.

II. STANDARDS OF PRACTICE.

A. A candidate for Fellowship in the American Academy of Optometry must be of good moral character and must conduct his practice on a high ethical plane. Ground floor locations are acceptable only when ethical physicians and dentists practice in like manner in the immediate vicinity of the applicant. (Photographs of ground floor offices must accompany application form.)

B. An applicant, when a practicing optometrist, must have been in professional practice, according to Academy standards, for a period of three years before acceptance for Fellowship. Application to the Academy can be made at any time.

C. Fellows of the American Academy of Optometry are forbidden from committing and condoning any of the following practices:

1. Sensational publicity.
2. Advertising (see Section II E below).
3. The display of advertising of merchandise or service.
4. Use of bold face type or block listing in telephone books or directories.
5. The use of promotional material or methods such as slogans, catch prases, inducements, displays, circulars, etc.
6. Signs other than simple name plates.
7. Ground floor locations resembling a store.
8. Use of commercial equipment, such as cash registers, show cases, etc.
9. Fitting and/or servicing of eyewear other than in privacy.
10. Filling of ophthalmic prescriptions by dispensing for other refractionists, or selling ophthalmic devices.
11. Use of the word "optician" or words connoting the same in connection with the practice of optometry.
12. Public endorsement of any ophthalmic product.
13. Affiliation with any commercial venture which tends to discredit profession standing.
14. Itinerant practice of optometry.
15. Uethical, immoral, dishonest or criminal conduct.
16. Incompetence in the practice of optometry.
17. Fee splitting and rebating.

D. Stationery and other printed material may bear only the name and degree (title and name with qualifying specialty), address, telephone numbers, office hours, and profession. Printing or engraving of eyes, spectacles, spectacle frames, words referring to the competency of the individual is prohibited.

E. The use of professional cards in newspapers, church or school organs, or other media is prohibited. NOTE: Such may be accepted after review by the Executive Council, providing the majority of men in other professions within the same community use similar cards. Samples of such cards, together with those of the other professional men in the community must be submitted with the application.

F. Name signs or plates displayed to public view must conform in size, shape, and design with those used by other professional men in the immediate vicinity. Photographs of all such signs and name plates as well as photographs of those used by other professional men should be included with the application.

III. ADMITTANCE PROCEDURE.

A. All applicants must submit to the Secretary of the American Academy of Optometry, a complete file consisting of the following:

1. Application and fee to the A.A.O. Fee of $10.00 not returnable.
2. A signed Fellowship Pledge.
3. All required photographs.
4. Samples of all printed material.

B. The secretary notifies the Executive Council of the application and refers the file to the proper Regional Chairman on Admittance, or to the National Chairman.

C. An investigation of the applicant's character, mode of practice and office is

made by using Regional Committees on Admittance, Chapters, or local Fellows.

D. Upon approval of his file (III-A) and a favorable report of his investigation (III-C), the applicant is notified that ten case reports are required within the next six months. This requirement may be waived in the case of optometric scientists, optometric educators or non-practicing optometrists with the approval of the Committee on Admittance and unanimous vote by the Executive Council.

E. After the acceptance of the ten case reports by the Committee on Admittance, the applicant must next appear for a clinical and written examination at the annual meeting of the Academy, or before a local authorized examining committee. This requirement may be waived for applicants living outside the continental United States and non-practicing optometrists.

F. After the applicant completes the examinations, the Committee on Admittance reports the findings on the applicant to the Secretary. The report on the applicant is then sent to the Executive Council by the Secretary's office and final approval of the applicant rests with this Council.

IV. PREPARATION OF CASE REPORTS.

A. All reports must be of patients examined by the applicant and may include:
   1. Errors of refraction.
   2. Muscle imbalances.
   3. Reading problems.
   4. Conditions requiring Contact Lenses.
   5. Aniseikonia.
   6. Pathology.
   7. Amblyopia and subnormal vision.
   8. Conditions requiring Orthoptics and visual training.

B. Reports together with field charts, graphs and drawings must be in duplicate: the original being sent to the Committee on Admittance, the copy to be retained by the applicant. All reports, graphs, etc., become the property of the American Academy of Optometry and will not be returned to the applicant. The Academy can not accept the responsibility for loss of reports in transit.

C. Case reports and all supplementary data must be neatly typewritten, double spaced on 8½ x 11 inch paper. All graphs, charts, etc., pertaining to the report must be in proper order with each page numbered and bear the name and address of the applicant in the upper right hand corners.

D. Each individual report should be sufficiently long to explain the case and it is suggested that from 500 - 2,000 words are ample.

E. *Outline for the preparation of Case Reports.*
   1. Case designation—The cover sheet of each report must bear the following information:
      a. The general type of report (refractive, orthoptic, pathological, etc.)
      b. Patient's initials and address.
      c. A brief summary of the case (about 10 lines).
      d. Applicant's name and address.
   2. History—a complete and full case history must be recorded.
   3. External Examination—All findings of a significant nature and the tests used in their detection must be recorded.
   4. Ophthalmoscopy, Visual Field testing and other procedures used in the detection and evaluation of possible pathological conditions. Record all positive findings, if the case is primarily one of pathology the conditions must be fully and concisely described, giving your diagnosis together with the diagnosis, name and address of the consulting specialist if the case was referred. Information as to the final disposition should also be included.
   5. Refractive Examination—All objective and subjective findings must be recorded (when necessary designated gross or net), and the analyses which led to the final prescription and/or advice should be clear and brief.
   6. Orthoptics or Visual Training—Reports on training must be brief and clear, giving dates of first and last periods, reason for procedure adopted, and the final results.

7. Conclusion and Summary—The philosophy or reasons underlying the suggested and followed course must be valid, however they need not necessarily agree with those of the committee members. The significance of all findings must be written out. A diagnosis of the difficulty together with reasons for having arrived at this conclusion must be given. The prescription given (or not given) and the care and advice given the patient must be included. A general statement as to prognosis and care of case must be made.

V. CLINICAL AND WRITTEN EXAMINATION

A. Those applicants who are required to submit case reports must pass the following:
   1. The applicant must examine a patient before an examining committee which will grade the candidate pass or fail. It is Academy's policy to permit the applicant to follow his own practice routine and to advise the patient accordingly.
   2. The applicant must also analyze and give his disposition of three cases which may be taken from the files of the American Academy of Optometry. These reports are graded pass or fail on the basis of:
      a. Full recognition of symptoms indicated.
      b. Application of the procedure to fit the analysis made.
      c. Knowledge of the proper use of the procedures applied.

APPENDIX

I. *Variations in the usual procedure of admittance.* These variations, governed by the rules of the Committee on Admittance, with consent of the Executive Council, are as follows:
   A. Optometric Educators.
      1. These applicants must be in good standing in an accepted institution of higher learning and have had three years experience as a faculty member.
      2. An optometric educator is defined as one who has more than a half-time appointment at an approved school or college of optometry. If there is any doubt as to the status of the applicant, the Committee on Admittance may require the applicant to furnish a statement as to the nature of his teaching load. This statement should have the approval of the Dean or Director of the applicant's school or college.
      3. In the event the applicant under the provisions of this section conducts a part time practice, this practice must meet all Academy requirements as stated above.
      4. The applicant who qualifies as an optometric educator need not furnish case reports or take the clinical and written examination. This exception is made since it is normally expected that these applicants will make contributions to the literature.
   B. Scientists and Research Workers in the Visual and Allied fields.
      1. These applicants are accepted by individual merit on the basis of their contributions to the field of visual care. Their reputation and standing among their own and our colleagues must be above question.
      2. Applicants in this category must have three years experience in their chosen field.
      3. These applicants need not furnish case reports nor are they expected to take the clinical and written examination.
   C. Practicing optometrists living outside continental United States.
      1. Where a Chapter exists:
         Under these circumstances, the American Academy of Optometry accepts the screening and recommendations of the local Chapter. The Academy requires the Chapter to use its utmost vigilance and discretion in recommending applicants of the highest professional and ethical character. The Chapter may make its own rules not inconsistent with American Academy policy in these matters.
      2. Where no chapter exists:
         Each applicant must be accepted as a professional and ethical practitioner by the standards of his country. The applicant must fulfill all the

requirements for fellowship except that the clinical and written examination may be waived.

D. Optometrists in the Armed Forces.

1. Applicants in an administrative or non-practicing capacity.
   a. Applicants under this provision must have served in the Armed Forces three or more years, or
   b. If the applicant has not served in the armed forces for three years, any previous practice that he may have had must have been of such nature that it would have met all Academy standards.
   c. In the event that an applicant qualifies under either of the two provisions stated immediately above, the requirements for fellowship other than the approval of the Committee on Admittance and the Executive Council shall be waived.
2. Applicants who are practicing in the Armed Forces.
   a. Applicants under this provision must have served in the Armed Forces three or more years, or
   b. If the applicant has not served in the Armed Forces at least three years, any previous practice that he may have had, must have been of such a nature that it would have met all Academy standards.
   c. Applicants under the provisions of this section must prepare the necessary case reports. The Committee on Admittance may waive the clinical and written examination.

II. *General provisions.*

A. Anyone who has been admitted into the Academy by any of the categories in this Appendix and, who subsequently enters private practice, must furnish proof that this practice conforms to Academy standards.

Application forms may be secured by writing the Secretary, American Academy of Optometry, 1502 Foshay Tower, Minneapolis 2, Minnesota.

PROGRAM — FIRST WESTERN REGIONAL MEETING

AMERICAN ACADEMY OF OPTOMETRY

Berkeley — April 10-11, 1954

The first Western Regional meeting of the American Academy of Optometry will be held at the University of California, Berkeley, April 10-11. The two-day educational program will be held at Dwinelle Hall, Room 145, on the campus and the Informal Dinner at Shattuck Hotel at Berkeley. All Academy members are invited to attend and guests are welcome if sponsored by members. The undergraduate professional students at the three optometry schools on the West Coast have also been invited to attend the meeting. The general chairman is Dr. Merton Flom, School of Optometry, University of California. The program follows:

SATURDAY, APRIL 10, 1954

8:30 Verification of mail registration, Lobby Outside Room 145 Dwinelle Hall (near Sather Gate), University of California Campus.
8:30 Late registration, Shattuck Hotel Lobby, Allston Way and Shattuck Ave.
9:00 Welcome by Chairman, San Francisco-Bay Area Chapter of the American Academy of Optometry, Room 145 Dwinelle Hall.

9:10 Greetings by Kenneth B. Stoddard, Ph.D., Dean of the University of California School of Optometry.
9:20 Greetings by Meredith W. Morgan, Jr., Ph.D., President of the American Academy of Optometry.
9:30 The Filling-In Process. Gordon L. Walls, Sc.D., University of California School of Optometry.*
10:10 Anisooxyopia in Anisometropia. Frank W. Weymouth, Ph.D., Los Angeles College of Optometry, and Arthur Jampolsky, M.D., Stanford Hospital, San Francisco.
10:40 Correlation of Tests for Ocular Dominance. Arthur B. Emmes, O.D., Castro Valley, California.
11:10 Visual Investigations of Mentally Retarded Children—A study. Morris Kirschen, O.D., Modesto, California.
11:40 The Results of Prescribing Vertical Prisms From the Turville Test. Ferd T. Elvin, O.D., Oakland, California.
12:30 Lunch at the Faculty Club.
2:00 Accommodative Response in Asymmetric Convergence. Richard W. Spencer, O.D., and W. Keith Wilson, O.D., Forest Grove, Oregon. (By invitation.)
2:30 A Six Generation Pedigree of Congenital Zonular Cataract. Harry Jankiewicz, Ph.D., and Dale D. Freedberg, O.D., Los Angeles College of Optometry.
3:00 The Effect of Hyperventilation on the Human E.R.G. Mathew Alpern, Ph.D., John J. Faris, Ph.D., Paul Eskildsen, O.D., and Paul Garnett, B.Sc., Pacific University College of Optometry.
3:30 Accommodative Response of the Eye of an Old Cat to Electrical Stimulation of the Ciliary Ganglion. Elwin Marg, Ph.D., University of California School of Optometry, and Johnie L. Reeves, 1st Lt., USAF (VC) Aero Medical Laboratory, WPAFB, Ohio.
4:00 The Design and Development of a Contact Lens for Underwater Seeing. Curtis Nagel, O.D., Berkeley, California, and James F. Monical, O.D., West Sacramento, California.
4:30 A Qualitative Comparison of the Prism-Jump Method and the Tangent Screen Method of Plotting Scotomata. Charles Lawson, O.D., U. S. Army.
6:00 Cocktail Hour, University Room (north end), Shattuck Hotel.
7:00 Informal Dinner University Room (center), Shattuck Hotel. Speaker: Frank W. Weymouth, Ph.D., Los Angeles College of Optometry, Professor Emeritus, Stanford University Department of Physiology. "The Nonagenary of Physiological Optics."
9:00 Fellow and General Discussion Period, University Room (north end), Shattuck Hotel.

SUNDAY, APRIL 11, 1954

9:00 Hyperphoria Testing. Louis Jacques, O.D., Los Angeles, California.
9:40 The Appearance of a Hyperphoria Immediately Following Parturition. Marian K. Eakin, O.D., and Robert S. Eakin, O.D., Los Angeles, California.
10:00 An Unusual Case of Double Monocular Diplopia. Meredith W. Morgan, Jr., Ph.D., University of California School of Optometry.
10:40 A New Method for Measuring the Angle of Squint and the Angle of Anomaly. Merton C. Flom, O.D., University of California School of Optometry.
11:20 Variations in the A. C. A. Ratio and the Angle of Anomaly With Changes in the Fixation Distance—A Preliminary Report. Max Schapero, O.D., Los Angeles College of Optometry.
12:00 Luncheon Recess and Tour of the School of Optometry Building.
2:00 Business Meeting for Academy Members.
2:30 Differential Characteristics of True Exophoria and Intermittent Exotropia. Arthur Jampolsky, M.D., Stanford Hospital, San Francisco.
3:10 Contrasts Between Vision and Audition. Mark Rosenzweig, Ph.D., University of California Department of Psychology. (By invitation.)

*A ten minute discussion period follows all technical papers.

4:00 Accommodative Responses in Subjects With Low Visual Acuity. Gordon G. Heath, O.D., University of California School of Optometry.
4:40 Repeatability of Haploscopic Measurements of the AC/A—A Preliminary Report. Robert F. Harrigan, O.D., University of California School of Optometry.
5:20 Business Meeting.

CURRENT COMMENTS

Terry Judith Parkins
Editorial Assistant

Optometrists will confer a favor by sending news items of general interest for this department: such as relate to new instruments, clinical techniques, education, visual health and optometric legislation and organization.

INDIANA INTERPROFESSIONAL COMMITTEE ON EYE CARE MEETS

After six months of preliminary work the first regular meeting of the Indiana Interprofessional Committee on Eye Care was held at Indianapolis, February 7. The Indiana committee has a large representation from a number of State organizations and agencies. The following members were present, each as a delegate from his association or group. Charles Bishop, Indiana Association of Opticians; I. M. Borish, O.D., President, Indiana Optometric Association; Raymond Calvert, M.D., Indiana Academy of Ophthalmology and Otorhinolayngology; John Davey, O.D., Interprofessional Relations Committee, Indiana Optometric Association; Daniel O. Elliott, Jr., O.D., Indiana Chapter, American Academy of Optometry; Richard M. Harding, M.D., Indiana State Medical Association, Committee on Conservation of Vision; Henry W. Hofstetter, O.D., Ph.D., Division of Optometry, Indiana University; Ernest Long, Indiana Optical Wholesalers; Wilber Pell, Jr., attorney for Indiana Optical Wholesalers; Carl J. Rudolph, M.D., Indiana Committee for National Society for the Prevention of Blindness; Jeanne E. Rybolt, M.D., Indiana State Board of Health; Herschel Smith, M.D., Section on Ophthalmology and Otolaryngology, Indiana State Medical Association; Albert Stump, attorney for Indiana State Medical Association; Robert Tubesing, O.D., Indiana Committee for National Society for the Prevention of Blindness; Fred M. Wilson, M.D., Indiana University Medical Center.

Dr. Carl J. Rudolph, South Bend, was elected chairman and Dr. Robert W. Tubesing, Richmond, was elected secretary-treasurer.

Among the matters of mutual interest discussed were the advisability of curbing improper practices on the part of opticians by a State law regulating this practice; the visual examination and screening of all school children under a cooperative optometric-ophthalmologic

program through the State Board of Health: the elimination of substandard ophthalmic materials; the elimination of commercial advertising; the prohibition of physicians becoming employed in commercial optical stores; the quality and standards of corrective safety lenses and the manner to be followed in prescribing these; the filling out of blindness report slips for the State Board of Health, and the suit now filed against the King Optical Company by the attorney general of the State of Indiana.

Members of the committee were guests of the Indiana Optometric Association at a luncheon which preceded the meeting.

PROGRESS REPORT—SHEARD COMMEMORATIVE VOLUME

The manuscript for the Sheard Commemorative Volume has now been received from Dr. Charles Sheard and is being given its final editing, and is being prepared for publication by the staff. This material should be ready for the publishers late in April. The list of financial contributors to this commemorative book is still open and all readers who have not already done so may contribute any amount from $10 to $25 to help defray the costs of publishing this book. It will be a cloth bound book of from 300 to 400 pages. Contributors will receive a copy of the book as soon as published and also have their names listed as *friends of Sheard* in the book itself. As already reported the fund of money raised for this purpose reached the goal of $8,000 just before the first of the new year. Additional contributions may be sent to the Sheard Commemorative Volume Committee, American Academy of Optometry, 1501-1503 Foshay Tower, Minneapolis 2, Minnesota.

BACK ISSUES FOR COLLEGE OF OPTOMETRY OF ONTARIO

The College of Optometry of Ontario is in need of the following back issues of the AMERICAN JOURNAL OF OPTOMETRY to complete their sets of annual volumes of this magazine and to permit their holdings of our issues to be bound for permanent use by students and faculty.

Optometrists able to supply one or both of the missing issues listed below are urged to write or send same direct to Dr. E. J. Fisher, Dean, College of Optometry, 140 St. George St., Toronto, Ontaria, Canada.

Volume 23, 1946, January issue.
Volume 23, 1946, October issue.

The Journal office is unable to supply the above monthly issues.

SUMMER COURSES FOR OPTOMETRISTS—OHIO STATE

Five different subjects taught in periods of five days each for the

benefit of practicing optometrists are offered during July, 1954, by the Ohio State University School of Optometry, Columbus, Ohio.

These courses are open to any optometrist. Each course is limited to ten participants and the enrollment will be filled in the order that the applications are received. Courses will begin on Monday morning and end Friday afternoon.

Nine different instructors will participate in the courses. Six are from the Ohio State University and three are guest instructors from other colleges. Guest instructors will be Dr. Merrill J. Allen, Indiana University, Dr. Robert E. Bannon, formerly of Dartmouth College and Dr. Harold Simmerman, Pennsylvania State College of Optometry.

The registration fee for each course is fifty dollars. Housing at a moderate rate will be provided on the Ohio State University Campus for those who desire it. Interested optometrists may direct their application to Dr. V. J. Ellerbrock, School of Optometry, Ohio State University, Columbus 10, Ohio. At least one-half the registration fee should accompany the letter of application. Checks should be made payable to the Ohio State University.

The dates, subjects and instructors are as follows:

July 5- 9—"Advanced Practical Optometry." Drs. Merrill J. Allen and George W. Knox.
July 5- 9—"Orthoptics." Drs. V. J. Ellerbrock and Neil J. Bailey.
July 5- 9—"Aniseikonia." Drs. Robert E. Bannon and Jack W. Albright.
July 12-16—"Advanced Practical Optometry." Drs. Merrill J. Allen and George W. Knox.
July 12-16—"Orthoptics." Drs. V. J. Ellerbrock and Neil J. Bailey.
July 12-16—"Diseases of the Eye and Visual Pathway." Drs. Harold Simmerman and Jay Enoch.
July 19-23—"Contact Lenses." Drs. V. J. Ellerbrock and K. S. Zinnicker.

THE OPTICAL FAIR—A MUST FOR JUNE

The Optical Fair, Chicago, Illinois, June 5-10, 1954, promises to be the most outstanding thing of its kind ever done in this country. The list of participants will include virtually all manufacturers of materials, supplies and instruments used by optometrists. In our May issue we plan to list the exhibitors along with a summary of their exhibits. Optometrists everywhere should now plan to attend and take part in this educational exhibition which will be held at the world famous Palmer House.

NATIONAL BOARD EXAMINATION

Parts I and II of the 1954 examinations of the National Board of Examiners in Optometry will be given on May 13-15 in each of the following cities: Forest Grove, Oregon; Berkeley, California; Los

Angeles; Houston; Chicago; Memphis; Columbus, Ohio; Philadelphia; New York City and Boston. Application should now be made to the Secretary, Dr. John Uglum, Crow Building, Mitchell, South Dakota.

NEWS BRIEFS

Academy men are not only in the news but are doing a lot of traveling as well. Mr. G. H. Giles, London, author, editor and secretary of the British Optical Association will visit America this month and speak at several optometric meetings on both coasts. . . . Dr. Herman J. Raile, Menomonie, Wisconsin, is going to Europe where he will speak before optometrists in Berlin. . . . Our own Dr. Monroe J. Hirsch, associate editor of this publication, will be absent from his practice in Ojai, California, for two weeks this month while he fills speaking dates before optometric groups including the celebration at the School of Optometry, Columbia University, New York City. . . . Dr. J. I. Pascal will speak on Strabismus at Yale University in April. . . . One of our British Chapter members, Mr. H. Freeman, will visit this country in May and June and is open for speaking dates on newer British refractive techniques. His itinerary will carry him as far west as Chicago. Local optometric associations wishing to book this outstanding British optometrist, educator and inventor may reach him at 493 Roman Road, London E. 3., England. . . . The Los Angeles College of Optometry is celebrating its 50th anniversary. . . . The second annual Institute on Occupational Vision was held at the University of Wisconsin this month. Dr. Charles S. Bridgman, member of faculty, was in charge. . . . The A.O.A. Committee on Research and Standards, Dr. Meredith W. Morgan, Jr., Dr. Frederick W. Sinn and Dr. Glenn A. Fry have just released their recommendations on "Prescription Standards and Tolerances" on heavy board stock for use in all laboratories. Copies may be secured from the A.O.A. office in either St. Louis or Minneapolis. . . . Mrs. John E. Martin, President of the women's auxiliary of the A.O.A. attended the White House conference on Highway Safety in Washington in February. . . . The annual conference for optometric technicians was held by the O.E.P. at Fort Worth, Texas, in February. Orthoptic training was stressed. . . . The National Research Council, Washington, D. C., has announced the appointment of Dr. Henry A. Knoll, Dean of the Los Angeles College of Optometry, to the American Committee of the International Commission of Optics. . . . Shuron is presenting at attractive new spectacle case which holds two pairs of glasses. It is called the "Two Suiter", which is probably a better name than the "Double Cheaters". . . .

COLUMBIA BICENTENNIAL PROGRAM

"The Role of Visual Care in the Acquisition and Utilization of Knowledge," was the theme of a two day symposium by the Columbia University School of Optometry, March 17-18, 1954, at New York City. Dr. Isidore Finkelstein, faculty member, was in charge of the program that included Frederick W. Brock, D.O.S., Columbia University; Charles B. Huselman, Ph.D., Miami University; G. H. Giles, London Refracting Hospital and Secretary, British Optical Association; Ernest J. Giglio, M.S., Columbia University; Monroe J. Hirsch, Ph.D., Optometrist, Ojai, California; Helen Wallace, M.D., New York Medical College; Evelyn Eisnaugle, Department of Health, State of Ohio; Vincent Ellerbrock, Ph.D., School of Optometry, The Ohio State University; Alfred Lit, Ph.D., Columbia University; Joseph Tiffin, Ph.D., Purdue University; R. A. Sherman, D.O.S., Bausch and Lomb Optical Company; Robert E. Bannon, D.O.S., American Optical Company; Edward Steinberg, M.S., Columbia University; A. L. Kornsweig, M.D., New York University; Bernard Rosett, M.S., Columbia University; Glenn A. Fry, Ph.D., School of Optometry, The Ohio State University; Paul Boeder, Ph.D., American Optical Company; Karl M. Dallenbach, Ph.D., University of Texas, and Daniel Woolf, Ph.D., Columbia University. This special event was part of the Columbia University Bicentennial Program.

CORRESPONDENCE

SUPPLEMENTARY EMPLOYMENT

To the Editor:

As usual the recent Journal was superb and educational, but a little mentioned problem, presented in this issue was to the point and effective. And, that was Dr. Lloyd's article on supplementary employment during the critical initial year in professional practice. This is *not* to be condemned although it may take one out of his field for a temporary period, for it is essential in most instances if success, financially and otherwise, is to be attained.

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Dr. Glenn A. Fry, Chairman
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Revised 1953

INSPECTION ROUTINE of PRESCRIPTION LENSES	TOLERANCE	PROVISION
Type	As specified	
Color	As specified	
Surface defects	No waves, pits, scratches, watermarks, grayness, etc., visible to naked eye.	Inspected by grazing incidence of a beam of light from R40 type bulb.
Imperfections	No bubbles, striae, etc.	
Edge thickness	± 0.2mm.	Standard edge thickness is 1.8mm. at nasal strap except where lens power necessitates variation or where the thickness is specified differently.
Segment size, height and inset	± 0.25mm. pair must be symmetrical upon visual inspection.	
Lens size Rimless Bevel, for zyl Bevel, for metal	± 0.25mm. ± 0.25mm. Fit standard lens sizes for specified size	Measured along horizontal and vertical meridians passing through major reference point.
Bevel, rimless	Edges must be flat and smooth	
Bevel, metal	Bevel must be smooth and straight.	
Refractive power	0 – 3.00 ± 0.06 3.25 – 12.75 ± 0.12 13.0 – 16.75 ± 0.18 17.0 – 20.00 ± 0.25	The power in each meridian of a cylindrical or spherocylindrical lens is to be considered separately. In addition, the power of the cylindrical component is to be kept within the tolerance of ± 0.12D. In the case of bifocals, the total power through the segment is to be considered. In the case of fused bifocals, the tolerance for the total power through the segment may be increased 0.06D over and above the tolerance allowed for single vision lenses of the same power.
Cylinder Axis	0.00 – 0.50 ± 3° 0.62 – 1.12 ± 2° 1.25 and higher ± 1°	
Prism power and location of major reference point	Vertical ± 0.25Δ Horizontal ± 0.5Δ	This prism power as specified—measured at specified major reference point. A lens specified without prism to be treated as 0 Δ lens.
Eye size	± 0.25mm.	The horizontal dimension of a rectangle whose sides touch the edges of the lens.

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